GCSE Design and Technology

2017 New Specification
Links to Science and Maths

Links to Science and Maths

During the delivery of GCSE Design & Technology there will be many naturally occurring opportunities to develop links with maths and science based content. It is essential that these links are identified and explored fully in terms of Design and Technology theory, knowledge and understanding and the impact that these have in context to Design and Technology and not maths or science in isolation. Through their work in design and technology students must apply relevant knowledge, skills and understanding from key stage 3 and 4 courses in the sciences and mathematics.

This document provides some exemplar possibilities where opportunities for links with maths and science may be evident during the delivery of the GCSE course. These possibilities are by no means exhaustive and opportunities will vary centre by centre and depending on the 'in depth' route selected by candidates.

Knowledge and Understanding – links to Science

2.1.1 – Core Knowledge and Understanding	Science	D&T activity
(a) The impact of new and emerging technologies on the environment.	**Physics – Energy and energy transfer**	Understanding renewable and non - renewable energy sources and their application in D&T.
(c) How energy is generated and stored in order to choose and use appropriate sources to make products.	**Physics – Energy and energy transfer**	Understanding renewable and non-renewable energy sources including nuclear, geothermal, wind, hydro and solar.
(d) Developments in modern and smart materials.	**Chemical or physical change in properties of materials**	Knowledge and understanding of SMART materials and how they change due to external stimuli.

Engineering Design - Knowledge and Understanding

2.1.2 – In depth knowledge and understanding	Science	D&T activity
(a) Ferrous and non-ferrous metals.	**Physical properties including melting point, thermal and electrical conductivity.**	Understanding the physical properties of metals and how they can be used in D&T activities for specific purposes.
(b) Thermoforming and thermosetting polymers.	**Biology / Chemistry – natural plastics** **Chemistry – polymerization of plastics.** **Physical properties including melting point, thermal and electrical conductivity.**	Understanding the sources of polymers. Awareness of molecule structure and extraction from crude oil. Understand the physical properties of a range of polymers and apply them in D&T contexts.
(c) Electronic systems, including sensors and control devices and programmable components.	**Physical changes in electronic components**	Knowledge and understanding how an LDR and Thermistor resistance changes under varying conditions.
(d) Modern and smart materials and the effect of forces on materials and objects.	**Physics – electrical changes** **Chemistry – Components structure**	Conductive polymers and QTC. Increasing conductivity under compression forces. Electroluminescent film or wire and how it can be used with thermochromic film.
(e) Mechanical devices.	**Physics – Circuit diagrams and symbols.** **Input, process and output components and how they form simple and complex control systems.**	Understand and use mechanical components to form inputs, processes and outputs for desired D&T applications. Calculations of gear, pulley e.g. of work

Fashion & Textiles - Knowledge and Understanding

2.1.3 – In depth knowledge and understanding	Science	D&T activity
(a) Natural, synthetic, blended and mixed fibres.	**Physical properties of fibres and textiles. Sourcing natural fibres including plant, insect and animal based polymers.**	Understanding the origins and physical properties of fibres and how they can be used and combined in D&T activities for specific purposes.
(b) Woven, non-woven and technical textiles.	**Physical and mechanical properties of textiles and fibres.**	Understanding properties including strength, elasticity, absorbency, durability, water repellence and flammability.
(c) Thermoforming and thermosetting polymers.	**Biology / Chemistry – natural plastics Chemistry – polymerization of plastics. Physical properties including melting point, thermal and electrical conductivity.**	Understanding the sources of polymers. Awareness of molecule structure and extraction from crude oil. Understand the physical properties of a range of polymers and apply them in D&T contexts.
(d) Modern and smart materials.	**Physics – electrical changes Chemistry – Components structure**	Interactive textiles with electrical devices. Micro fibres, breathable materials, protective materials such as Kevlar, rhovyl, sun / UV protective materials.
(e) The sources, origins, physical and working properties of materials, components and systems	**Chemical bonding / adhesives to combine materials.**	Combining, joining fibres including heating, adhesive and stitching.

Product Design - Knowledge and Understanding

2.1.4 – In depth knowledge and understanding	Science	D&T activity
(a) Natural and manufactured timber.	**Physical properties of natural timber**	Understanding the origins and physical properties of natural timbers and how they can be used and combined in D&T activities for specific purposes.
(c) Ferrous and non-ferrous metals.	**Properties including physical and electrical**	Understanding the properties of metals including hardness, elasticity, conductivity, toughness, ductility, tensile strength and malleability.
(d) Thermoforming and thermosetting polymers.	**Properties including physical and electrical**	Understanding the properties of polymers including weight, hardness, elasticity, conductivity / insulation, and toughness.
(e) Modern and smart materials.	**Physical and chemical properties and changes**	Understanding of modern and SMART materials and how their properties can be used in D&T activities.
(f) The sources, origins, physical and working properties of materials, components and systems.	**Physical and chemical properties and changes**	Metals: sources / natural resources and non-renewable. Heat treatments, melting points and thermal / electrical conductivity. Timbers: sources / natural resources and non-renewable. Grain structure, strength and absorbency. Polymers: sources / natural resources and non-renewable. Heat treatments, thermal / electrical conductivity.

STEM – some links and resources to consider

- The Royal Society 'Invigorate' resources https://goo.gl/je7jkM
- Nuffield Foundation STEM projects https://goo.gl/w8s0dY
- https://www.stem.org.uk/resources
- The Smallpeice Trust https://goo.gl/VYAzXt

Knowledge and Understanding – links to Mathematics

Arithmetic and numerical computation	Mathematical skills	D&T activity
1a	Recognise and use expressions in decimal and standard form.	Calculation of quantities of materials, costs and sizes.

Example:

Calculating costs.
(Total fixed costs + Total variable costs) / Total units produced

The cost per unit should decline as the number of units produced increases, primarily because the total fixed costs will be spread over a larger number of units (subject to the step costing issue noted above). Thus, the cost per unit is not constant.

For example, ABC Company has a total variable costs of £50,000 and fixed machining costs of £30,000 which it incurred while producing 10,000 widgets. The cost per unit is:

(£30,000 fixed costs + £50,000 variable costs) / 10,000 units = £8 cost per unit

In the following month, ABC produces 5,000 units at a variable cost of £25,000 and the same fixed cost of £30,000. The cost per unit is:

(£30,000 fixed costs + £25,000 variable costs) / 5,000 units = £11/unit

- Recognise expressions in decimal and standard forms https://goo.gl/HV3X8h
- BBC GCSE Bitesize: powers and roots - higher https://goo.gl/YYIrVm

Knowledge and Understanding – links to Mathematics

Arithmetic and numerical computation	Mathematical skills	D&T activity
1b	Use ratios. Fractions and percentages	Scaling drawings, analysing responses to user questionnaires

Ratio Example:

A model boat is made to a scale of 1:30 (1 to 30). This scale concept can be applied to any units, so 1mm measured on the model is 30mm on the actual boat; 1cm measured on the model is 30cm on the actual boat.

a) If the 1:30 model boat is 15cm wide, how wide is the actual boat?

a) 1cm on the model = 30cm on the boat, so:
15cm × 30 = 450cm.
15cm on the model = **450cm** (4.5m) on the boat

15 × 30 = 450cm wide, or 4.5 metres

b) If the boat has a sail of height of 12m, how high is the sail on the model made to a scale of 1:30?

b) 30cm on the boat = 1cm on the model
so sail height on real boat ÷ 20 = sail height on model
1200cm (12m) on the boat = 1200cm ÷ 30 = **40cm** on the model

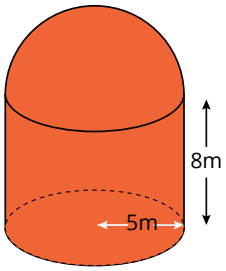
- BBC GCSE Bitesize: Ratio https://goo.gl/T6cB4d
- BBC GCSE Bitesize: Adding and subtracting fractions https://goo.gl/OHPmZ8
- Fractions, Decimals and Percentages Revision Quiz https://goo.gl/IKlFj5

Knowledge and Understanding – links to Mathematics

Arithmetic and numerical computation	Mathematical skills	D&T activity
1c	Calculate surface area and volume	Determining quantities of materials

Example:

A storage unit is in the shape of a hemisphere on top of a cylinder. The surface of the storage unit is to be painted. Calculate the area to be painted.



Solution

To find the surface area of the hemisphere, first find the surface area of a sphere.

Surface area of sphere = $4\pi r^2$

= $4 \times \pi \times 5^2$ (where r = 5m)

= 314.16m^2 (using 'π' button on calculator)

Surface area of hemisphere = 314.16 ÷ 2 = 157.1m^2

(Remember, units for surface area are units^2 as it is an area).

Next, find the surface area of the cylinder. Remember, only the curved surface is being painted so do not include the lid and base in the formula!

Surface area of cylinder (curved surface) = $2\pi rh$ (where r = 5m, h = 8m)

= $2 \times \pi \times 5 \times 8$

=251.33m^2

Total surface area of composite shape = 157.1 + 251.3 = 408. 4m^2

- math.com: Surface Area Formulas https://goo.gl/971XgU
- BBC GCSE Bitesize: Surface Area of Composite Solids https://goo.gl/7YaORg

Knowledge and Understanding – links to Mathematics

Handling data	Mathematical skills	D&T activity
2a	Presentation of data, diagrams, bar charts and histograms	Construct and interpret frequency tables; present information on design decisions

Example:

A student shows 5 different designs to 45 different potential end users to seek their opinion on which idea they thought was the best. The table below shows the results.

Design	Frequency
1	13
2	8
3	7
4	9
5	8
Total	45

If a table was shown as a pie chart, what angle would be needed to show idea 1?

Answer: To calculate the angles needed for pie charts, divide 360 by the total frequency (as there are 360° in a circle). 360 ÷ 45 = 8. Multiply this by the number in the 'idea 1' section, which is 13. 13 × 8 = **104˚**.

- BBC GCSE Bitesize: Representing data https://goo.gl/XZOFYs
- BBC GCSE Bitesize: Inter-quartile range, cumulative frequency, box and whisker plots - Higher https://goo.gl/Mp8FHS
- BBC GCSE Bitesize: Frequency density https://goo.gl/pBLD1d

Knowledge and Understanding – links to Mathematics

Graphs	Mathematical skills	D&T activity
3a	Plot, draw and interpret appropriate graphs	Analysis and presentation of performance data and client survey responses

Example:

A user trial is conducted to see whether concept A, B or C is the most user friendly. The results are shown below.

Concept	Frequency
A	10
B	23
C	39

Draw an accurate pie chart to display this information.

Answer:

The total number of users is 72. The pie chart will be a circle of 360°, therefore each user will represent 5° because 306/72=5.

Concept A = 10 × 5° = 50°
Concept B = 23 × 5° = 115°
Concept C = 39 × 5° = 195°

An accurately drawn pie chart would need to be presented.

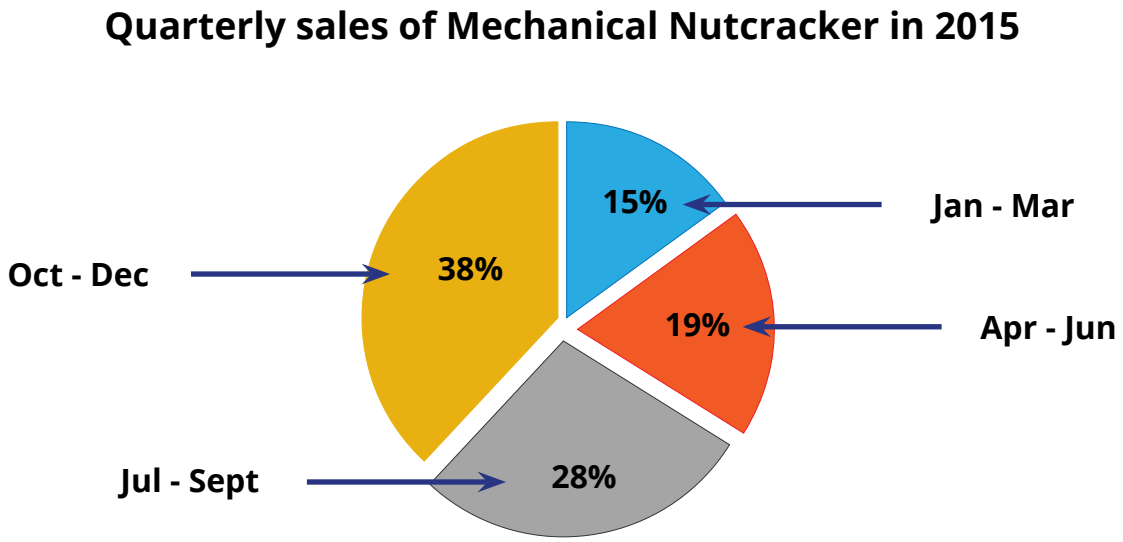
- BBC GCSE Bitesize: Pie charts and frequency diagrams https://goo.gl/HkXLlc
- Corbett Maths Pie Chart Questions https://goo.gl/CE5foM

Knowledge and Understanding – links to Mathematics

Graphs	Mathematical skills	D&T activity
3b	Translate information between graphical and numeric form	Extracting information from technical specifications

Example:

(d) The pie chart below shows the quarterly sales totals of a mechanical nutcracker for 2015.



(iii) A total of 5600 mechanical nut crackers were sold in 2015. Calculate how many are sold in the July – September quarter.
(*Show all workings*.) [2]

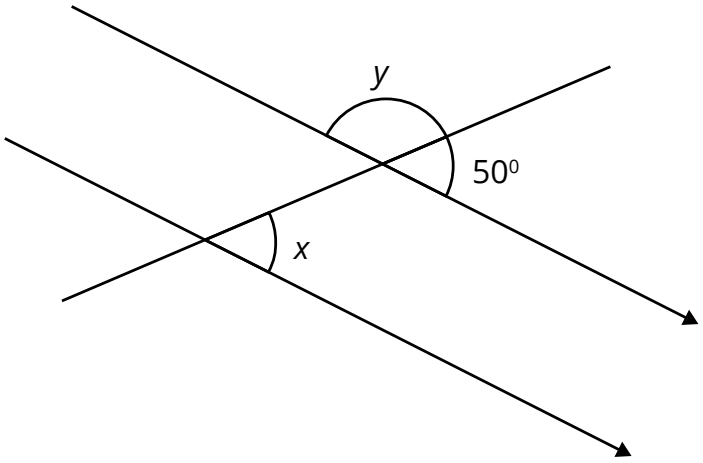
- BBC GCSE Bitesize: Interpreting pie charts and frequency diagrams https://goo.gl/rVE71Q

Knowledge and Understanding – links to Mathematics

Geometry and trigonometry	Mathematical skills	D&T activity
4a	Use angular measures in degrees	Measurement and marking out

Example:

A student is marking out a line across two parallel lines on a piece of acrylic.



a) State the angle x and give one reason for this.
b) Calculate the angle y.

Answers:

a) X is **50°**. Corresponding angles are equal.
b) is 180 - 50 = **130°**. Angles on a straight line add up to 180°

- BBC GCSE Bitesize: Angles, lines and polygons https://goo.gl/JES18F

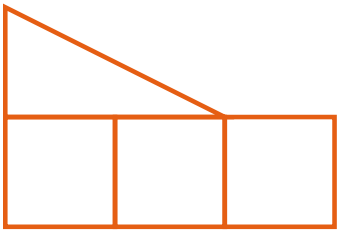
Knowledge and Understanding – links to Mathematics

Geometry and trigonometry	Mathematical skills	D&T activity
4b	Visualise and represent 2D and 3D forms including two dimensional representations of 3D objects	Graphic presentation of design ideas and communicating intentions to others

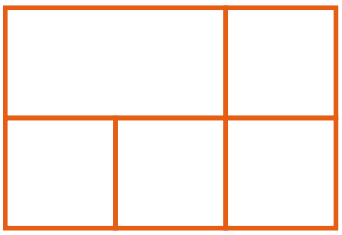
Example:

A concept model shown below is drawn in 2D forms from three different positions. In the space below, sketch the 3D shape that would be seen from each view point.

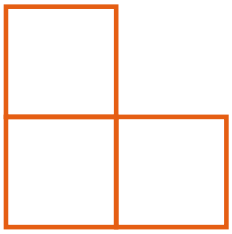
Front Elevation:



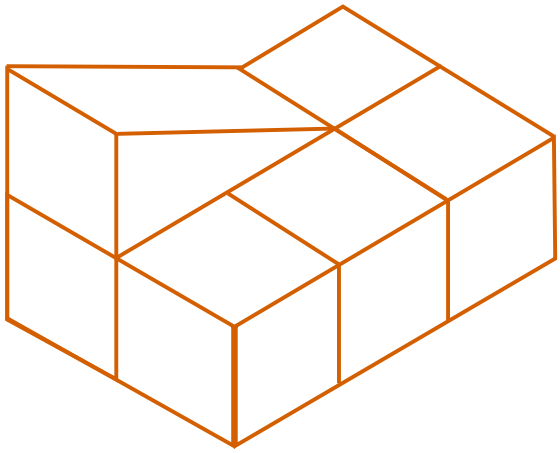
Plan:



Side elevation:



Answer:



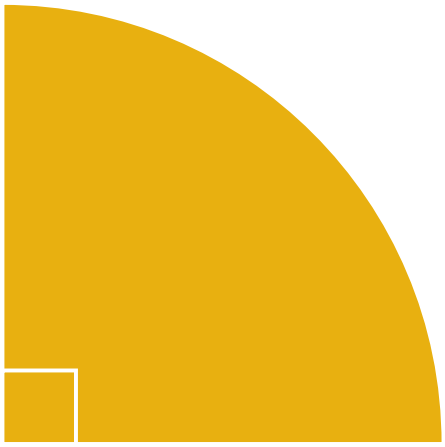
- BBC GCSE Bitesize: 3D shapes https://goo.gl/4lQ8Nl
- BBC GCSE Bitesize: 2D and 3D shapes https://goo.gl/y0dhQH

Knowledge and Understanding – links to Mathematics

Geometry and trigonometry	Mathematical skills	D&T activity
4c	Calculate areas of triangles and rectangles, surface areas and volumes of cubes	Determining the quantity of materials required

Example:

A student needs to draw the shape below accurately during the prototyping design ideas. Calculate the area of the shape shown below if the horizontal base line is 5cm long



Answer

Area = πr^2

The radius is 5cm, represented by the horizontal line.
Area = 3.142 × 5 × 5 = 78.57, 78.57/4 = 19.64cm^2

- BBC GCSE Bitesize: Geometry and measures https://goo.gl/DYaJHQ

WJEC / Eduqas resources

- WJEC / Eduqas eResource https://goo.gl/fXbVwa

Acknowledgements

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