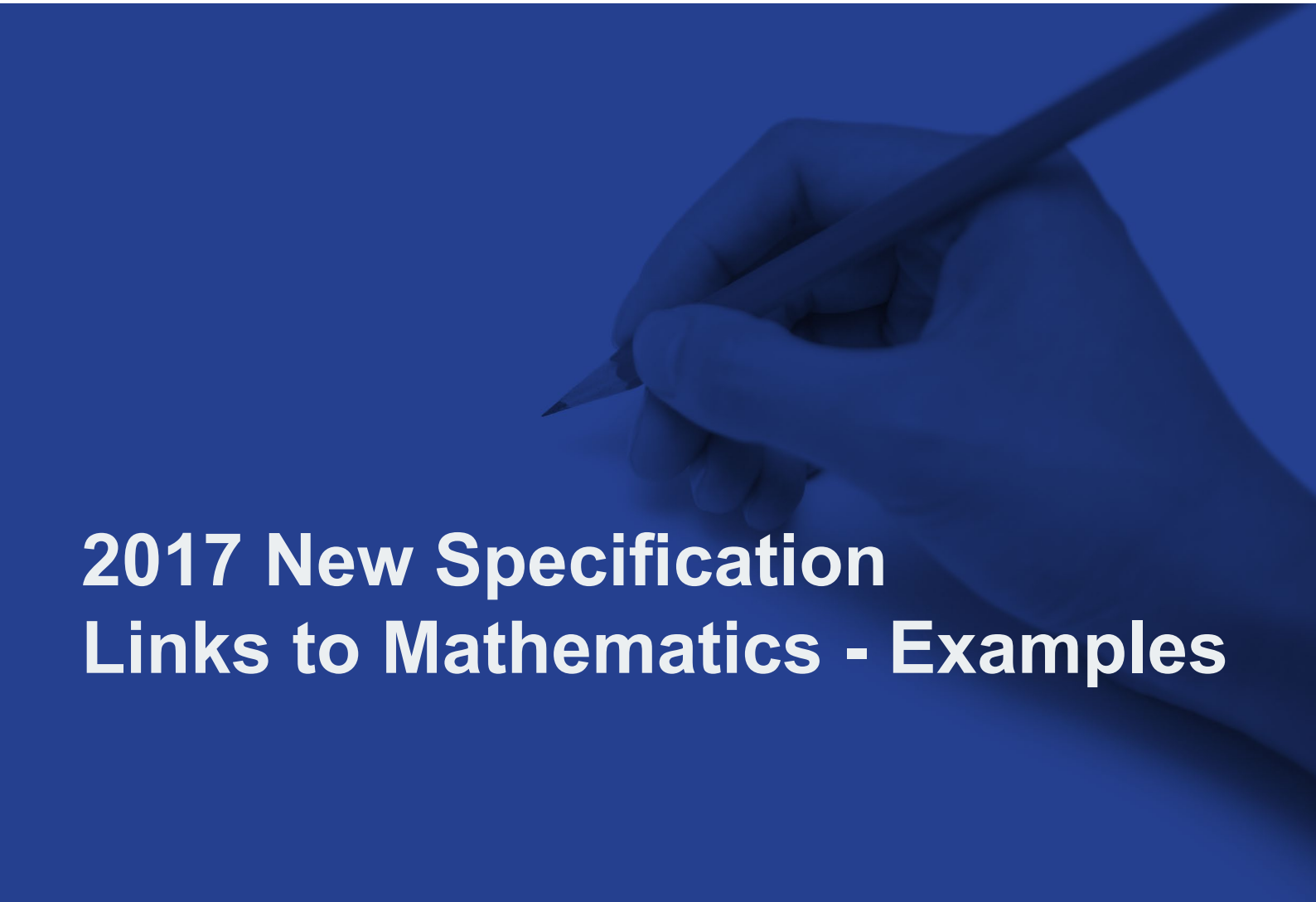
GCSE Design and Technology



2017 New Specification
Links to Mathematics - Examples

Links to mathematics

Ref	Mathematical skills requirements	Examples of D&T applications	Examples of specification content
1	*Arithmetic and numerical computation*		
a	Recognise and use expressions in decimal and standard form.	Calculation of quantities of materials, costs and sizes.	NEA (assessment criteria (c)) – details of dimensions. 2.1 in-depth, 4. Stock forms, types and sizes in order to calculate and determine the quantity of materials or components required.
b	Use ratios, fractions and percentages	Scaling drawings, analysing responses to user questionnaires	NEA (assessment criteria (a)) – analysis of information. 2.1 core, 7. The functions of mechanical devices, to produce different sorts of movement, changing the magnitude and direction of forces.
c	Calculate surface area and volume.	Determining quantities of materials.	NEA (assessment criteria (d)) – manufacturing a prototype. 2.1 in-depth, 4. Stock forms, types and sizes in order to calculate and determine the quantity of materials or components required

Links to mathematics

Ref	Mathematical skills requirements	Examples of D&T applications	Examples of specification content
2	*Handling data*		
a	Presentation of data, diagrams, bar charts and histograms	Construct and interpret frequency tables; present information on design decisions.	NEA (assessment criteria (c)) – communicating ideas and proposals to a third party.
3	*Graphs*		
a	Plot, draw and interpret appropriate graphs.	Analysis and presentation of performance data and client survey responses.	NEA (assessment criteria (a)) – analysis of information.
b	Translate information between graphical and numeric form.	Extracting information from technical specifications.	NEA (assessment criteria (a)) – analysis of information.
4	*Geometry and trigonometry*		
a	Use angular measures in degrees.	Measurement and marking out, creating tessellated patterns.	NEA (assessment criteria (d)) – manufacturing a prototype.
b	Visualise and represent 2D and 3D forms including two dimensional representations of 3D objects.	Graphic presentation of design ideas and communicating intentions to others.	NEA (assessment criteria (c)) – communicating ideas and proposals to a third party.
c	Calculate areas of triangles and rectangles, surface areas and volumes of cubes.	Determining the quantity of materials required.	NEA (assessment criteria (d)) – manufacturing a prototype. 2.1 in-depth, 4. Stock forms, types and sizes in order to calculate and determine the quantity of materials or components required.

Links to Mathematics - Examples

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:

Adding and subtracting numbers in standard index form:
Convert them into ordinary numbers, do the calculation, then change them back if you want the answer in standard form.

$4.5 \times 10^4 + 6.45 \times 10^5$
$= 45{,}000 + 645{,}000 = 690{,}000$
$= 6.9 \times 105$

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

Links to Mathematics - Examples

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

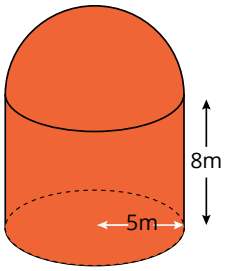
- BBC GCSE Bitesize: Ratio https://goo.gl/T6cB4d
- BBC GCSE Bitesize: Adding and subtracting fractions https://goo.gl/OHPmZ8
- Fractions, Decimals and Percentages Revision Quiz https://goo.gl/IKlFj5

Links to Mathematics - Examples

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

Links to Mathematics - Examples

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

Links to Mathematics - Examples

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.

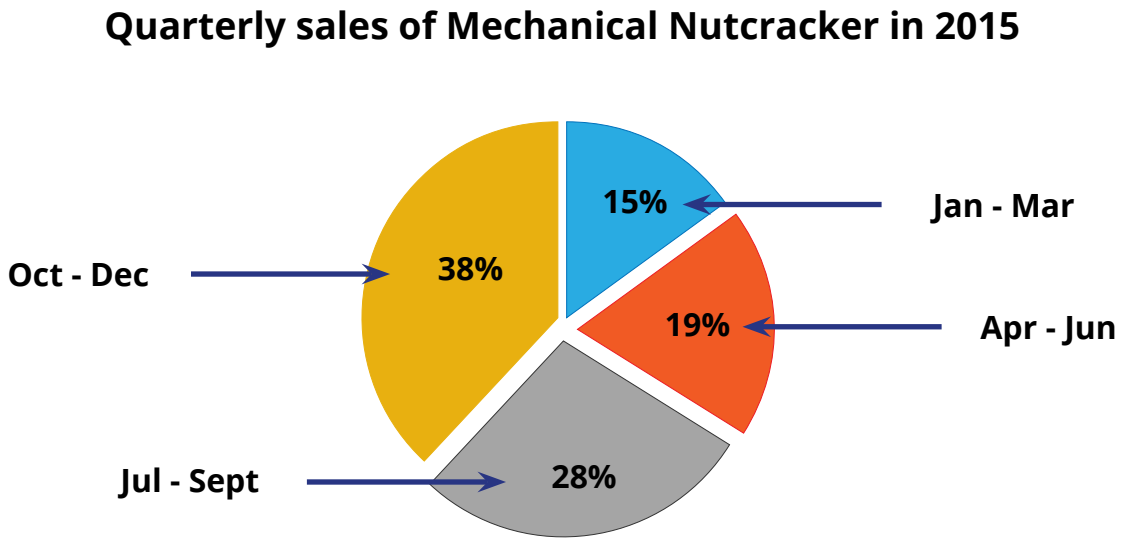
- BBC GCSE Bitesize: Pie charts and frequency diagrams https://goo.gl/HkXLlc
- Corbett Maths Pie Chart Questions https://goo.gl/CE5foM

Links to Mathematics - Examples

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.



(i) State the quarter with the highest sales [1]

(ii) Give a reason why January - March quarter shows the lowest sales [1]

(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]

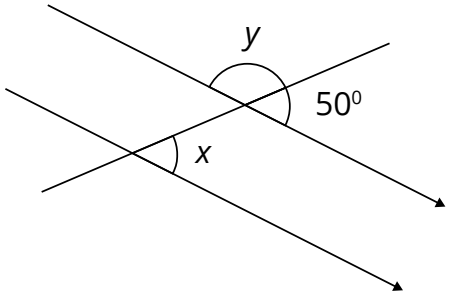
- BBC GCSE Bitesize: Interpreting pie charts and frequency diagrams https://goo.gl/rVE71Q

Links to Mathematics - Examples

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

Example:

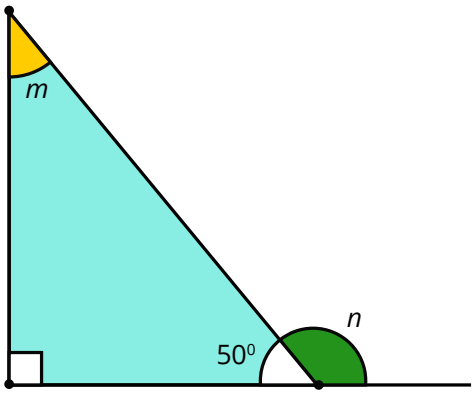
A student is marking out a line across two parallel lines on a piece of acrylic.



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°

A triangular piece of mild steel is required as part of a concept. Study the image of the triangle below and calculate the missing angles n and m.



Answers:
a) n = 180 - 50 = **130°**.
b) m = 50+90 =140, 180 (internal angles of a triangle)-140 = **40°**.

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

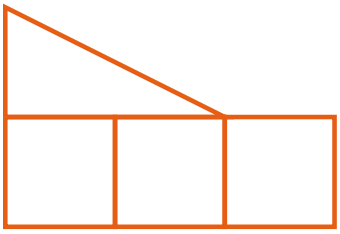
Links to Mathematics - Examples

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

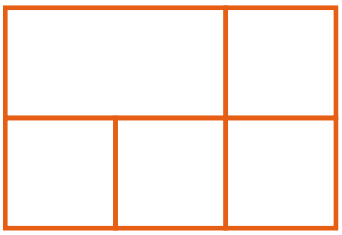
Example:

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.

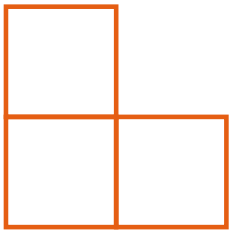
Front Elevation:



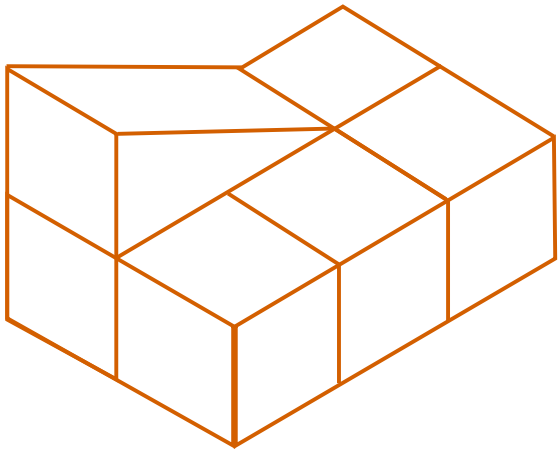
Plan:



Side elevation:



Answer:



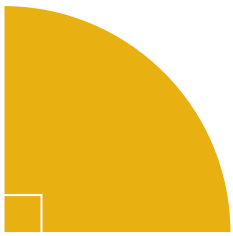
- BBC GCSE Bitesize: 3D shapes https://goo.gl/4lQ8Nl
- BBC GCSE Bitesize: 2D and 3D shapes https://goo.gl/y0dhQH

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:

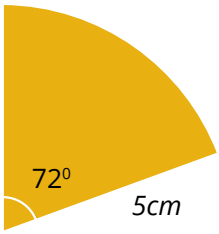
A student needs to draw the shape below accurately during the prototyping design ideas. Calculate the area of the shape shown below if the horizontal base line is 5cm long



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

Calculate the length of the arc of the shape shown below.



Answer
Circumference of circle = πd or **2πr**
Circumference = 10 π cm and the angle 72**°** is $^1/_5$ of 360°

Arc length = $^1/_5$ of 10π = 2π = 6.283cm (3 d.p.)

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

Acknowledgements

- Drawing (cover), blackred / Getty Images