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| **UNIT 6: Real-life and algebraic linear graphs, quadratic and cubic graphs, the equation of a circle, plus rates of change and area under graphs made from straight lines** |

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**SPECIFICATION REFERENCES**

N13 use standard units of mass, length, time, money and other measures (including standard compound measures) using decimal quantities where appropriate

A8 work with coordinates in all four quadrants

A9 plot graphs of equations that correspond to straight-line graphs in the coordinate plane; use the form *y* = *mx* + *c* to identify parallel **and perpendicular lines**; find the equation of the line through two given points, or through one point with a given gradient

A10 identify and interpret gradients and intercepts of linear functions graphically and algebraically

A11 identify and interpret roots, intercepts, turning points of quadratic functions graphically; …

A12 recognise, sketch and interpret graphs of linear functions, quadratic functions, simple cubic functions, the reciprocal function  with *x* ≠ 0, …

A14 plot and interpret … graphs of non-standard functions in real contexts to find approximate solutions to problems such as simple kinematic problems involving distance, speed and acceleration

A15 **calculate or estimate gradients of graphs and areas under graphs (including quadratic and non-linear graphs) and interpret results in cases such as distance–time graphs, velocity–time graphs … (this does not include calculus)**

A16  **recognise and use the equation of a circle with centre at the origin; find the equation of a tangent to a circle at a given point**

A17 solve linear equations in one unknown … (including those with the unknown on both sides of the equation); find approximate solutions using a graph

A18 solve quadratic equations (**including those that require rearrangement**) algebraically by factorising, **by completing the square and by using the quadratic formula**; find approximate solutions using a graph

R1 change freely between related standard units (e.g. time, length, area, volume/capacity, mass) and compound units (e.g. speed, rates of pay, prices, density, pressure) in numerical and algebraic contexts

R10 solve problems involving direct … proportion, including graphical … representations

R11 use compound units such as speed, … unit pricing, …

R14 … recognise and interpret graphs that illustrate direct and inverse proportion

**PRIOR KNOWLEDGE**

Students can identify coordinates of given points in the first quadrant or all four quadrants.

Students can use Pythagoras’ Theorem and calculate the area of compound shapes.

Students can use and draw conversion graphs for these units.

Students can use function machines and inverse operations.

**KEYWORDS**

Coordinate, axes, 3D, Pythagoras, graph, speed, distance, time, velocity, quadratic, solution, root, function, linear, circle, cubic, approximate, gradient, perpendicular, parallel, equation

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| **6a. Graphs: the basics and real-life graphs**  (N13, A8, A9, A10, A14, A15, R1, R11) | **Teaching time**  5-7 hours |

**OBJECTIVES**

By the end of the sub-unit, students should be able to:

* Identify and plot points in all four quadrants;
* Draw and interpret straight-line graphs for real-life situations, including ready reckoner graphs, conversion graphs, fuel bills, fixed charge and cost per item;
* Draw distance–time and velocity–time graphs;
* Use graphs to calculate various measures (of individual sections), including: unit price (gradient), average speed, distance, time, acceleration; including using enclosed areas by counting squares or using areas of trapezia, rectangles and triangles;
* Find the coordinates of the midpoint of a line segment with a diagram given and coordinates;
* Find the coordinates of the midpoint of a line segment from coordinates;
* Calculate the length of a line segment given the coordinates of the end points;
* Find the coordinates of points identified by geometrical information.
* Find the equation of the line through two given points.

**POSSIBLE SUCCESS CRITERIA**

Interpret a description of a journey into a distance–time or speed–time graph.

Calculate various measures given a graph.

Calculate an end point of a line segment given one coordinate and its midpoint.

**OPPORTUNITIES FOR REASONING/PROBLEM SOLVING**

Speed/distance graphs can provide opportunities for interpreting non-mathematical problems as a sequence of mathematical processes, whilst also requiring students to justify their reasons why one vehicle is faster than another.

Calculating the length of a line segment provides links with other areas of mathematics.

**COMMON MISCONCEPTIONS**

Where line segments cross the *y*-axis, finding midpoints and lengths of segments is particularly challenging as students have to deal with negative numbers.

**NOTES**

Careful annotation should be encouraged: it is good practice to label the axes and check that students understand the scales.

Use various measures in the distance–time and velocity–time graphs, including miles, kilometres, seconds, and hours, and include large numbers in standard form.

Ensure that you include axes with negative values to represent, for example, time before present time, temperature or depth below sea level.

Metric-to-imperial measures are not specifically included in the programme of study, but it is a useful skill and ideal for conversion graphs.

Emphasise that velocity has a direction.

Coordinates in 3D can be used to extend students.