Qualification Accredited

OCR Oxford Cambridge and RSA

LEVEL 3 CERTIFICATE

CORE MATHS A (MEI)

H868

For first teaching in 2015

Introduction to Quantitative Reasoning Scheme of Work

Version 1

MEI Mathematics Education Innovation ®

www.ocr.org.uk/maths

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H868

The competence statements in the scheme of work below are from the Introduction to Quantitative Reasoning 90 glh component. This needs to be taught with either the Statistical Problem Solving component or the Critical Maths component to make up a full qualification.

Statements in brackets are partly addressed in the relevant section.
Use of ICT is integrated throughout the scheme of work.

Produced by MEI on behalf of OCR.

Risk (approx. 3 hours)	Overview
	• This section deals with the probability of adverse events – often these probabilities are approximate or based on data from the (recent) past. • Comparison of risks in the form 1 in n can be difficult for students; they need to understand that 1 in 10 is a higher risk than 1 in 50, for example. A common misconception is to assume that the higher number means a higher risk. • There is an opportunity here to check student understanding of percentages; can they convert between risks expressed as 1 in *n*, a percentage and a decimal? • Understanding risk is important in business, science and in careers which involve looking after other people such as teaching and health. • There is also an opportunity to introduce the idea of logarithmic scales for comparing risks that differ widely in size. This can be left until the section on logarithmic scales. Logarithmic scales are used in biology, chemistry and in social sciences.

Competence statements	Objectives	Resources	Examples of questions to promote thinking

(IQRu3)
IQRu7
IQRu8
(IQRl6)
(IQRf5)
	Core
	• Understand that risk can be expressed as a probability or in the form 1 in n or as a description e.g. "once in n years"
	• Understand that risk assessments typically involve both likelihood and impact.
	• Be able to put risks in order of likelihood.
	Extension
	• Understand that in a logarithmic scale equal intervals mean multiplication by the same number.
	• Know that logarithmic scales are useful for comparing numbers of very different sizes.
		Integral resources – OCR (MEI) Level 3 IQR
		Probability and risk 1: Risk
		Other resources
		These resources are external to the Integral site.
		2845 ways of spinning risk
		Paling perspective scale: a logarithmic scale for risk
		How risky is life? (This Bowland resource was designed for KS3 but may provide some useful information)
			• The average risk of a household being burgled in 2008/9 was 2.5%. Express that risk in a different way. And another way.
			• Here are two statements from two different websites. Do they mean the same?
			  • 34.8 out of a thousand insurance claims from the LS13 area are for burglary.
			  • The risk of being burgled in the LS13 area is 34.8 out of 1000.
			• Which of these three risks is the smallest? The largest?
			1.8%, 1 in 50, 13 in 1000.
			• A risk of 2% in any given year is equivalent to once in how many years?

Percentages review (approx. 4 hours)	**Overview** • This section reviews percentages starting from the context of finance and extending to other contexts. Some students will already have a good understanding of percentages from GCSE and will need to spend very little time on this section. The use of percentages in the risk section will indicate how much work students are likely to need on percentages. • In the context of finance, linking percentage to number of pence per pound may help students. • Students may be quite good at working out simple percentages of an amount, such as 10% and 50% of £25, but find it much more difficult to work out what percentage something has changed by; e.g. a leaf grows from 2.8 cm to 3.1 cm, what is the percentage change? Using a spreadsheet will require them to thinkabout what steps the calculation needs and so help them work with harder numbers. • Some students may not have used multipliers for percentages at GCSE; they will need to do so in order to work with interest rates for loans and savings. • For students with a good understanding of percentages, this section can be extended to including repeated percentage change, appreciation and depreciation. For students who need quite a bit of revision of percentages, that can be left till later. • A good understanding of percentages is important for everyday life, understanding the news and in business, science and social science. • Many careers will include the use of spreadsheets; this section is an opportunity to use basic formulas and graphs in a spreadsheet to work with and compare percentage change.		
Competence statements	**Objectives**	**Resources**	**Examples of questions to promote thinking**
IQRf5 (IQRf2, 3) IQRq1, 2, 3, 4 (IQRq7)	***Core*** • Be able to use a standard calculator (scientific or graphical) to calculate with percentages. • Be able to work out percentages mentally, when appropriate. • Be able to read information from a standard spreadsheet. • Be able to enter formulae and data into a spreadsheet. • Be able to interpret simple formulae on a spreadsheet given in terms of cell references. • Be able to do calculations involving percentages in context. • Be able to use multipliers when working with percentages. ***Extension*** • Repeated percentage change for appreciation and depreciation (see later).	Integral resources – OCR (MEI) Level 3 IQR Financial problem solving 1: Working with percentages A (Percentages for comparison) and B (Percentage change) Other resources These resources are external to the Integral site. Standards Unit N7 Using percentages to increase quantities MyMoneyWeek Use the Wonderful World of Work section to learn about wages and income tax. Forsooth Examples of misunderstanding of percentages in the news.	• A pair of trousers goes down in price from £25 to £23. How can you work out the percentage decrease? Now how can you work out the percentage decrease when the population of a town drops from 27 500 to 26 400? • The target for waiting time in accident and emergency in hospitals is that at least 98% of people should be seen within 4 hours. What information would you need to check whether the target has been met? • Is it possible to have a percentage that is over 100%? If so, when is it possible? If not, why not? • The price of a pair of shoes goes down by 20%. What percentage would the price need to go up by to get back to the original price?

Statistics introduction (approx. 5 hours)	**Overview** • This section provides an overview of the statistical problem solving cycle, the collection of data and the use of statistical diagrams and summary statistics to make sense of the data. • Students should be encouraged to see statistics as a means of problem solving rather than as a collection of techniques. • The focus of work on statistical diagrams should be on their use to make sense of data, using a spreadsheet to draw and label appropriate diagrams and interpretation of diagrams. • The collection and interpretation of data is important in science and social science and is also used in many careers, in politics, business and in understanding the news. The ability to spot errors and rogue figures is part of the CBI's definition of functional numeracy.		
Competence statements	**Objectives**	**Resources**	**Examples of questions to promote thinking**
IQRs1,2,3 and IQRs5-16 (IQRs17) IQRq7	***Core*** • Be able to decide what data to collect to address a statistical question; understand and use appropriate methods of data collection. • Be able to read and interpret tables. • Understand that a sample gives information about the population. • Use a spreadsheet to draw statistical diagrams. • Interpret and criticise/improve statistical diagrams: box and whisker plots, dot plots, scatter diagrams, bar charts, pie charts, histograms, cumulative frequency diagrams. • Put scatter diagrams in order of correlation. • Be able to recognise skewness. • Be able to recognise data values which are unlikely to be accurate. • Use and interpret mean, median and mode and select an appropriate measure of central tendency (average). • Calculate and interpret measures of spread: range, inter-quartile range and semi interquartile range. Know that standard deviation is a measure of spread. • Be able to calculate a weighted mean. ***Extension*** • Know when it is appropriate to use a weighted mean.	**Integral resources – OCR (MEI) Level 3 IQR** Statistics 1: Introduction & collecting data Statistics 2: Statistical techniques **Other resources** These resources are external to the Integral site. Gapminder video: 200 countries, 200 years, 4 minutes Standards Unit S4 Understanding mean, median, mode and range Standards Unit S5 Interpreting bar charts, pie charts, box and whisker plots Standards Unit S6 Interpreting frequency graphs, cumulative frequency graphs, box and whisker plots Relevant and engaging stats: using spreadsheets KS4 statistics statements: true or false Ugly data visualisation Census at School: graph it! Relevant and engaging stats: teaching through statistical investigations	• Show students a correct statistical graph from a reputable source on the internet. Ask them to either make a statement about the graph or to ask a question about the graph. • Show students a set of data. Suggest a type of statistical diagram and ask whether it is or is not appropriate for the data – they should explain reasoning. • Find a set of five data values with mean 4, mode 2 and median 3. Find another set of five data values with this property. And another one. • For your set of five data values, a sixth data value joins the data set. What could the sixth value be if the mean is still 4? What could it be if the mode is still 2? What could it be if the median is still 3? • The Office for National Statistics uses the median when working out average wage. Why do they use this measure of central tendency?

Introducing estimation (approx. 3 hours)	Overview • This section introduces the importance of estimation; there is a later section which takes estimating calculations further. • Encourage students to practice estimation skills throughout the course; being able to recognise when an answer is reasonable is an important skill for life. • Estimation is included in the requirements for biology, chemistry, psychology, geology and environmental science A levels. The ability to spot errors is included in the CBI's definition of functional numeracy. • When making an estimate, students need to make sensible assumptions about the sizes of numbers that will make the working easier; this is a good opportunity to follow up by introducing the modelling cycle and making explicit what students have done. Students need to be able to communicate their method of estimation clearly.		
Competence statements	**Objectives**	**Resources**	**Examples of questions to promote thinking**
IQRe1,2 IQRp1,2,3 IQRp6,7	***Core*** • Be able to make a rough estimate of a quantity from available information. • Be able to make an estimate when doing a calculation. • Be able to identify and use simplifying assumptions when doing an estimate. • Know that different assumptions when making an estimate lead to different answers. • Be able to communicate methods used when doing an estimate. ***Extension*** • Be able to find upper and lower bounds for an estimate of a calculation.	**Integral resources – OCR (MEI) Level 3 IQR** Roughly speaking Estimation starter Dealing with errors PowerPoint Tiger populations Some of estimates of calculations **Other resources** These resources are external to the Integral site. There is the opportunity to connect to statistics here. Estimation of population size based on a sample Estimation of height from step length Could also do estimation of height from foot length.	• Estimate how many loaves of bread you need to make sandwiches for 30 people. What information do you need? What assumptions have you made? • Show a scatter diagram of e.g. foot length against height. What is a good estimate of the height of someone with a foot length of 22 cm? What is a reasonable estimate? How big or small would the estimate need to be before you thought it was unreasonable? • Make up an easy example of a question which needs an estimation. • Make up a hard example of a question which needs an estimation. What makes it hard?

Foreign exchange (approx. 4 hours)	Overview • It will be helpful if students have done the work on multipliers in Percentages B and the introduction to estimation before doing this section. In this section, they will use multipliers to work out equivalent amounts in different foreign currencies and also estimate equivalent amounts in different foreign currencies. • In this section, students learn to interpret and work with foreign exchange information presented in a variety of ways – it would be useful to ask them to bring examples of information about foreign currency exchange which they see advertised or in their area. • Nearly all students will go abroad at some time and need to be able to decide where to change their money and to calculate rough equivalent prices in pounds when shopping abroad.		
Competence statements	**Objectives**	**Resources**	**Examples of questions to promote thinking**
IQRf1, 2, 3 IQRf8,9 (IQRe1,2)	***Core*** • Be able to find the information needed to make a foreign exchange rate estimate or calculation. • Be able to make an estimate when doing a calculation. • Be able to identify and use simplifying assumptions when doing an estimate. • Be able to communicate methods used when doing an estimate. • Be able to do a foreign currency exchange calculation or estimate, with or without commission. • Understand foreign currency exchange information in the form "We sell at 1.54, we buy at 1.69" ***Extension*** • Be able to decide what the most advantageous exchange rate is without having to work out how much would be received from each exchange rate.	**Integral resources – OCR (MEI) Level 3 IQR** Financial problem solving 2: Foreign exchange **Other resources** These resources are external to the Integral site. Compare currency exchange rates	• Marina is shopping in Canada. She sees a pair of shoes priced at $50. She uses her phone to look up the exchange rate and finds that £1 is worth 1.79 Canadian dollars. Roughly how much do the shoes cost in pounds? Can you find two prices in pounds that the cost must be between? • Use the foreign exchange rate information (displayed) to make up an easy question and a hard question. What makes the hard question hard? • From a display of exchange rates obtained from the local area or the internet, explain how you would decide where to go to change pound to Euros? Euros to pounds? • You want to change £200 to Euros. (show up to date exchange rate) The bank will only pay out in foreign notes. How much will you need to change to get only notes? • Some banks offer higher rates the more money you change (display current information); at the borderline between rates, how much extra would you get by changing an extra £1?

Algebra (approx. 3 hours)	**Overview** • This section is largely a review of GCSE work on formulas and equations. The main ways that all students are likely to encounter algebra in future life is when using a spreadsheet or when using a formula related to their future work or study. It will be helpful if students have already used spreadsheets for calculations before doing this section. • In some careers, formulas are given in words rather than in terms of algebraic symbols – this is typical in nursing, for example. • For scientists who want to communicate their work internationally, algebraic symbolism is understood in the same way all over the world. We live in a scientific age and it is important for all informed citizens to appreciate the power of algebraic notation.		
Competence statements	**Objectives**	**Resources**	**Examples of questions to promote thinking**
IQRa1,2, 3 IQRq(5), 6	***Core*** • Be able to solve simple equations using algebraic manipulation. • Be able to substitute values into a formula given in symbols or words or as a flow chart. • Be able to change the subject of a formula. • Be able to solve more complicated equations using trial and improvement (including with the help of a spreadsheet). ***Extension*** • Be able to represent a situation mathematically using a formula or equation.	**Integral resources – OCR (MEI) Level 3 IQR** Representing the real world mathematically 1 : Algebra **Other resources** These resources are external to the Integral site. Improving learning in mathematics: mostly algebra Formulas used in nursing calculations Mathematics text books or examination papers in foreign languages can be used to show that diagrams and algebra can be understood in any language. WJEC Mathematics GCSE papers in Welsh Dutch school leaving mathematics examination	• Find an algebraic equation which has $x = 3$ as a solution. Now find a different equation which has $x = 3$ as a solution. And another one. • The equations $\mathbf{x} - 4 = 5$, $2\mathbf{x} - 8 = 10$, $2.5\mathbf{x} - 10 = 12.5$, all have the same solution. Can you explain why? Can you find another equation like this? • Describe and explain the relationship between the formula for the area of a rectangle and the formula for the area of a triangle. • Show a formula in words; can you write it in symbols? What are the advantages and disadvantages of the two ways of writing it? • Show a formula in symbols; can you write it in words? What are the advantages and disadvantages of the two ways of writing it? • Show a formula in symbols; can you write it as a flow chart? What are the advantages and disadvantages of the two ways of writing it?

Graphs and gradients (approx. 5 hours)	**Overview** • It will be helpful if students have either done the algebra section before this section or if they do both sections alongside each other. • Interpreting graphs is important in science, business, economics, psychology and social science; it is also important for future life and work – graphs are used in magazines and reports.		
Competence statements	**Objectives**	**Resources**	**Examples of questions to promote thinking**

IQRg1-9
IQRm3,6
	Core
	• Know that the independent variable is plotted on the horizontal axis of a graph.
	• Be able to construct a table of values for a graph from a simple formula and use it to plot the graph.
	• Be able to use a graph to construct a table of values.
	• Be able to work with graphs drawn from a variety of contexts.
	• Recognise graphs of direct and inverse proportion.
	• Be able to linearise a graph where the dependent variable is directly proportional to some function of the independent variable.
	• Understand the relationship between a straight line graph and the formula connecting the variables graphed.
	• Understand the terms displacement, distance, velocity, speed, acceleration.
	• Be able to convert between commonly used units.
	• Be able to find the gradient of a straight line graph and interpret it in context, taking account of the scales on the axes
	• Be able to find the gradient of a curve at a point by drawing a tangent and interpret it as a rate of change.
	Extension
	• Be able to sketch a speed-time graph to go with a given distance-time graph.
		Integral resources – OCR (MEI) Level 3
		IQR Representing the real world mathematically 2: Graphs **Other resources**
		These resources are external to the Integral site. Improving learning in mathematics: mostly algebra The moving man
			• What is the same and what is different about $2\mathbf{x} + 3 = 7$ and $\mathbf{y} = 2\mathbf{x} + 7$?
			• Show a graph and its equation on screen; ask students for a point on the graph, below the graph, above the graph.
			• Show a graph of sales or population over time; where are sales/ number of people growing fastest? Describe what the graph shows.
			• Ask students to bring a graph from one of their other lessons – show graphs to the class and ask them to describe what the graph shows.
			  • Which of the graphs show direct proportion?
			• Show a straight line graph on screen using a graph plotter; ask students for the equation of a graph that:
			  • is parallel to the given graph
			  • crosses the given graph on the *y*-axis
			  • crosses the given graph to the left of the *y* axis
			  • crosses the given graph on the ***x***-axis.
			• Ask students to give the equation of a graph that goes through the origin (0, 0) but is not a straight line. What could be plotted on the axes to make it a straight line graph?

Appreciation and depreciation (approx. 5 hours)	Overview • Appreciation means growth, depreciation means getting smaller – the words are usually applied to increase and decrease in value. • Savings increase in value, by the percentage shown by the interest rate – this can be either constant or changing but it is often easier to assume it is constant to give an idea of how the savings might grow over time. This is a form of modelling. • This section needs to be done after the earlier percentage work on multipliers. • This section makes use of mathematical modelling, considering growth or decrease by a constant percentage rate. It would be useful for students to connect this to the modelling cycle. • Ideas of appreciation and depreciation are important when thinking about investments (including pension funds), the value of cars, houses and other major purchases including those made by businesses. • The effect of inflation on prices should also be considered here.		
Competence statements	**Objectives**	**Resources**	**Examples of questions to promote thinking**
IQRf5, 6, 7 IQRp4 (IQRI3,4, 5) (IQRq3, 4, 5) (IQRf14)	***Core*** • Use percentages to work with appreciation or depreciation. • Compare a constant percentage change model with actual values over time. • Be able to work out an average annual percentage growth (or reduction) rate for a given change over a period. • Understand inflation APR, AER • Be able to use an index number to compare a number or value to that in a base year. ***Extension*** • Consider the effects of inflation on the value of money over time.	**Integral resources – OCR (MEI) Level 3 IQR** Financial problem solving 1C: Repeated percentage change Integrating Mathematical Problem Solving- The mathematics of economics: Real terms **Other resources** These resources are external to the Integral site. Car depreciation from what car? BBC inflation tracker World Bank inflation rates	• Show a graph of inflation over time. When were prices rising fastest, slowest, falling? • How would you explain to someone else how to interpret the graph of inflation? • World Bank data says that the rate of inflation in Venezuela in 2013 was 40.6%. Give an example of how a price changed over the year. Give an example of how a price changed, on average, over a month. • An average car is worth about 25% of its original price when it is 5 years old. Sketch a graph to show how the value of the car drops over its first five years. • The retail prices index (RPI) was 100 in January 1974. It was 119.9 in January 1975. What was the rate of inflation for the year from Jan 1974 to Jan 1975? The RPI was 342.6 in January 1984; what was the average annual rate of inflation from Jan 1974 to Jan 1984? The RPI was 54.6 in Jan 1964; compare the average rate of inflation from Jan 1964 to Jan 1974 to that from Jan 1974 to Jan 1984.

Standard form (approx. 4 hours)	Overview • Some students will have used standard form to express very large or very small numbers at GCSE. Others may not be familiar with this. They are likely to encounter numbers expressed in standard form when working with repeated percentage change on either a calculator or a spreadsheet and need to be able to understand the way that the calculator or spreadsheet shows the number. • It would be useful to do this section soon after the section on appreciation and depreciation. • Standard form is used in science to write very large or small numbers; it is also called scientific notation.		
Competence statements	**Objectives**	**Resources**	**Examples of questions to promote thinking**
IQRI1, 2 IQRq1, 2, 3	***Core*** • Be able to read and write large or small numbers in standard form. • Understand how a calculator or spreadsheet shows a number in standard form and be able to enter a number in standard form to a calculator or spreadsheet. • Be able to calculate with numbers in standard form. ***Extension*** • Be able to calculate with numbers in standard form without using a calculator.	**Integral resources – OCR (MEI) Level 3 IQR** Working with exponentials 1: Standard form **Other resources** These resources are external to the Integral site. Improving learning in mathematics: estimating length using standard form	• The distance from the earth to the sun is about 1.5×10^8 km. How far is this in metres? In centimetres? • If you double a number in standard form does it change the power of 10 always, sometimes or never? • What is wrong with $1.8 \times 10^{-12} \div 3 = 1.8 \times 10^4$? How many ways can you find to put this right?

Measures and scaling (approx. 4 hours)	Overview • It will be helpful if students have done the section on foreign currencies before this section. That provides a context where ratio is used and so will enable students to practise some of the skills used in this section before moving on to use them in a wider variety of contexts. If also done after the standard form section, applications to biological contexts of magnification with microscopes can be used. • The idea of scale factors is basic to many areas of uses of mathematics such as maps, scale drawings, photographs from microscopes or space. • Some students will need to interpret scale drawings and photographs as part of future work and study but most students will use online or paper maps when planning a journey or researching a place they intend to visit. • Relationships between lengths, areas, weights and volumes of similar figures are especially important in biology but also in manufacturing when considering how to scale up a container to a larger size.		
Competence statements	**Objectives**	**Resources**	**Examples of questions to promote thinking**
IQMm1, 2, 4, 5 IQMn1	***Core*** • Recognise and use relationships between lengths, areas, weights and volumes of similar figures to model real-world situations. • Interpret and apply regulations involving time, length, area and volume. • Interpret diagrams, maps and scale drawings and use them in problem solving. • Work with representations of 3-D objects in 2-D such as plans, elevations, sketches and isometric drawings. • Use ratio and proportionality in realistic contexts. ***Extension*** • Produce a poster based on the mathematics of B movie monsters	**Integral resources – OCR (MEI) Level 3 IQR** Measures and scaling 1: 2D and 3D shapes **Other resources** These resources are external to the Integral site. Nuffield: Costing the Job Nuffield: Points of View MAP: Developing a Sense of Scale MAP: A Golden Crown	• The code of practice for workspaces says "The total volume of the room, when empty, divided by the number of people normally working in it should be at least 11 cubic metres. In making this calculation a room or part of a room which is more than 3.0m high should be counted as 3.0m high. The figure of 11 cubic metres per person is a minimum and may be insufficient if, for example, much of the room is taken up by furniture etc." • How many people could work in this classroom? • Give the dimensions of a room that 24 people could work in. And another one. • How many mm^2 in a cm^2? How could you convince someone who wasn't sure? • I have a recipe for a cake to be baked in a 7 inch diameter cake tin. I want to make a cake the same height in a 10 inch diameter cake tin; how much more of the ingredients should I use? • Draw round a coin on a piece of paper. Imagine the coin is a magnified picture of one bacteria cell. The diameter of the bacterium is 1×10^{-6} m. What is the length scale factor of your magnified picture?

Exponentials and logarithmic scales (approx. 5 hours)	**Overview** • Appreciation by a constant percentage is a form of exponential growth. Depreciation by a constant percentage is a form of exponential decay. • It will be helpful if students have done both the appreciation and depreciation sections and the algebra and graphs sections before this section. • The modelling cycle can be introduced here in the context of the use of exponential growth as a model. • Exponential growth is used as a model for population growth and so has applications in all the social sciences as well as business, economics and science. • Exponential decay is important in business when modelling depreciation and also in science for radioactive decay. Radioactive decay is important in carbon dating in archaeology and also in considering issues to do with nuclear power so a basic understanding of it is important for all citizens. • Examples of logarithmic scales are pH in chemistry, decibels and the Richter scale for earthquakes. Logarithmic scales are sometimes used in graphs showing economic data to make the scale more manageable.		
Competence statements	**Objectives**	**Resources**	**Examples of questions to promote thinking**
IQRl3, 4, 5, 6 IQRq3, 5, 7 IQRp2, 3, 4	***Core*** • Be able to explore exponential growth and decay, including interpreting output from a spreadsheet. • Be able to represent and interpret exponential growth or decay in a graph. • Know that for exponential growth and decay over time, the amount is multiplied (or divided) by a constant factor for fixed time. • Be able to use exponential growth as a model and compare it with actual data. • Be able to solve equations of the forms $x^5 = 35$. • Be able to solve equations of form $1.05^x = 8.2$ using trial and improvement. • Be able to use and interpret a logarithmic scale on a graph. ***Extension*** • Know that the value equidistant between a and b on a linear scale is the arithmetic mean $\left(\frac{a+b}{2}\right)$ but for a logarithmic scale it is the geometric mean. $\left(\sqrt{ab}\right)$	**Integral resources – OCR (MEI) Level 3 IQR** Working with exponentials 2: Exponential growth and decay Working with exponentials 3: Logarithmic scales **Other resources** These resources are external to the Integral site. Phet radioactive dating game Gapminder world allows logarithmic scales World income distribution	• An investment grows by 20% a year. How long will it take to double? • A car falls in value by 20% a year. How long will it take to halve in value? • What if the percentage is different to 20%? • Explain what happens if an exponential growth graph changes from a linear to a logarithmic scale on the vertical axis. • A friend tells you she heard about a woman who borrowed money to buy a washing machine, got behind with repayments and ended up losing her house because she owed so much money. Is that possible?

Modelling (approx. 4 hours)	Overview • It will be helpful if students have already encountered the modelling cycle, when doing estimation or when working with exponentials. This section makes the modelling process more explicit and allows a number of models to be developed in different contexts. • It will be best if this section is done after the algebra, exponentials and graphs sections. • Modelling is intrinsic to the use of mathematics in real life situations, especially in science and economics. Due to the easy availability of computers, mathematical models are used to predict how an epidemic might unfold, the possible effects of climate change and the long term effects of national economic strategy. It is helpful for every informed citizen to have a general understanding of mathematical modelling.		
Competence statements	**Objectives**	**Resources**	**Examples of questions to promote thinking**
IQRp1-5 IQRf13	***Core*** • Be able to identify simplifying assumptions that allow a problem to be modelled. • Develop or choose a simple mathematical model for a real world situation. • Be able to use a model to make predictions. • Be able to use a demand curve as a model for the relationship between price and demand, knowing that demand is on the horizontal axis and price on the vertical axis. • Be able to compare the outcomes from a model with actual data, information, experience or common sense. • Be able to appraise the assumptions underlying a model critically. • Understand that a simple model can give useful answers but may need to be improved. • Be able to communicate mathematical results clearly and effectively. ***Extension*** • Investigate how mathematical models are used in another subject/ profession.	**Integral resources – OCR (MEI) Level 3 IQR** Representing the real world mathematically 3: Modelling **Other resources** These resources are external to the Integral site. Malthus	• In 1798 Malthus wrote an essay on population which said (essentially) that population grows exponentially but food production only grows in a linear way so there will eventually not be enough food unless population is controlled. Was he right? • What do you think the population of the world was in Malthus's time? Were you right? • How realistic is a straight line demand curve as a model for the relationship between price and demand?

The Normal distribution (approx. 3 hours)	**Overview** • The Normal distribution is used as a model in biology and psychology; related distributions are used in economics. • The approach intended here is relatively informal and does not depend on any formulae. Students should see the Normal curve as the limit of histograms where the bars get progressively narrower. • This section needs to be after the earlier work on statistics, where statistical diagrams are reviewed; it would also be useful to do this after the section on modelling to emphasise that the Normal distribution is an idealised model. It may also be helpful to do this section after the section on upper and lower bounds to make the connection with the information we have about values from the Normal distribution.		
Competence statements	**Objectives**	**Resources**	**Examples of questions to promote thinking**
IQRs18-21 IQRp2	***Core*** • Know that the Normal distribution is a model which can be used for real data and recognise a Normal curve. • Know that the distribution is symmetrical about the mean for the population but understand that histograms for samples will usually not be exactly symmetrical. • Understand that area represents frequency in a histogram. • Know that, for a Normal distribution, values more than 3 standard deviations from the mean are very unusual and that approximately 95% of the data lie within 2 standard deviations of the mean and that 68% (just over two thirds) lie within one standard deviation of the mean. • Be able to use mean and standard deviation to calculate a *z*-score and use *z*-scores for comparison or quality control. • Interpret *z*-score as number of standard deviations away from the mean. • Be able to estimate the mean and standard deviation from a Normal curve. • Be able to interpret a Normal probability plot from statistical software. ***Extension*** • Be able to find the median from a Normal probability plot.	**Integral resources – OCR (MEI) Level 3 IQR** Statistics 3: The Normal distribution **Other resources** These resources are external to the Integral site. Census at School: Is our height Normal? Explore histograms of height using the Census at School Data Tool	• Two samples from Normal distributions have the same number of data items. Sketch the two distributions if they have the same standard deviation but different means. What if they have the same mean but different standard deviations? • Sketch the histogram for a set of data which you are certain has not come from a Normal distribution. • Give an example of a variable which you think might be Normally distributed. Try to get data which will enable you to check this. • A student gets a z-score of -0.5 on a test. How did his performance compare to the others who did the same test?

Statistical problem solving (approx. 4 hours)	Overview • This section focuses on using the whole statistical problem solving cycle to address a statistical question and interpret the results in the light of the original plan. • It should be done after the other statistical section. • These skills are essential for anyone who is likely to use statistics in science, business or social science and is also a useful insight for all informed citizens to ensure that they have an insight into the power and limitations of statistical enquiry.		
Competence statements	**Objectives**	**Resources**	**Examples of questions to promote thinking**
IQRs1-4	***Core*** • Be able to decide what data need to be collected in order to answer a question requiring statistical evidence. • Be able to use a suitable method for collecting data, taking ethical considerations into account, and judge whether data are of sufficient quality. • Be able to present and analyse the data and so provide an answer to the original question. • Be able to interpret the answer to the question and decide whether it is realistic.	**Integral resources – OCR (MEI) Level 3 IQR** Statistics 4: Bring it all together **Other resources** These resources are external to the Integral site. Relevant and engaging statistics: Using the whole problem solving approach	• What do you want to find out? • Why is it worth finding out? • How will you get data to enable you to find out? • How can you decide whether you have found out what you were trying to find out? • Are the data realistic? • Does your answer seem reasonable?

Probability (approx. 4 hours)	Overview • It will be best to do this section after the review of percentages; it follows up on the section on risk to look at more complex probabilities. • An understanding of conditional probability is important in both medicine and law so this section is especially relevant to students who intend to work in health, law and social work as well as for sport and for every citizen who may have to interpret medical or legal information one day either as a patient or on a jury. • When working with conditional probabilities, either in a two way table or in a tree diagram, students may find that they are better able to understand the situation if they work with representative frequencies than if they work with probabilities. Of course, if they are happier working with probabilities and able to use them successfully then that is also fine.		
Competence statements	**Objectives**	**Resources**	**Examples of questions to promote thinking**
IQRu1-6	***Core*** • Be able to identify relevant equally likely outcomes in appropriate contexts and recognise when outcomes are not equally likely. • Be able to count equally likely outcomes in appropriate contexts and hence estimate a probability. • Be able to estimate probability as long-run relative frequency. • Be able to interpret two-way tables and use them to calculate or estimate probability. • Understand the difference between dependent and independent events and be able to calculate probability in simple cases. • Be able to work with a tree diagram when calculating or estimating probability, including conditional probability. ***Extension*** • Being able to work with conditional probabilities in a variety of context.	**Integral resources – OCR (MEI) Level 3 IQR** Probability and risk 2: Probability Probability and risk 3: Probability trees **Other resources** These resources are external to the Integral site. Gerd Gigerenzer on risk Screening tests from Understanding Uncertainty	• 5% of the population have a medical condition. A test for the condition correctly identifies 90% of the people with the condition and 95% of the people without the condition. Describe in everyday language what would happen if the general population was tested with this test. • Which of the numbers would need to change to make the test more accurate?

Upper and lower bounds for calculations (approx. 3 hours)	Overview • This section should be done after the introduction to estimation. It completes this work to consider how to make and justify upper and lower bounds for a calculation. • In manufacturing, lengths of components can vary slightly; it is important to know how long or short a component can be and still be acceptable – this is expressed by giving a tolerance for the length of the component. • Getting the best possible estimate for a value which is difficult or impossible to calculate exactly can be very useful. Getting an interval in which you are sure that the actual value must lie can be even more useful as it allows intelligent forward planning. • In more advanced work, the idea of an interval estimate is combined with probability to give a confidence interval. Confidence intervals are used in opinion polls and in monitoring target setting.		
Competence statements	**Objectives**	**Resources**	**Examples of questions to promote thinking**
IQRe3, 4	***Core*** • Be able to make and justify upper and lower bounds for a calculation. • Be able to select or justify an appropriate level of accuracy for a calculation. • Be able to present error bounds or tolerances on diagrams and in writing. • Understand that different levels of tolerance are appropriate in different situations. • Understand error bounds in percentage form. ***Extension*** • The idea of a confidence interval as an interval that we are pretty sure (but not 100% sure) that the actual value must lie in.	**Integral resources – OCR (MEI) Level 3 IQR** Roughly speaking Estimates of calculations Calculations with error bounds Significant figures rule of thumb **Other resources** These resources are external to the Integral site. Introduction to confidence intervals	• A piece of wood is 12 cm ± 0.5 cm wide. How wide could it be exactly? • A cupboard needs to be 70 cm ± 0.5 cm wide. Give examples of widths of cupboard that are within tolerance. Give examples that are out of tolerance. • The number of people who can comfortably attend an event is 340 ± 10 %. How many people could be at the event? • I measure the length and width of a rectangle to the nearest mm. How sure can I be about the accuracy of the area I calculate?

Costing and financial problem solving (approx. 5 hours)	**Overview** • This section brings together earlier work on finance and introduces the financial problem solving cycle as a way of organising thinking when addressing a financial situation arising in either business or in personal life. • This section should be done after the other financial sections – the example problems can then be tacked over time to consolidate the financial content of this course; this may be more effective than attempting to do them all, one after another. There is also the opportunity here for students to tackle different problems, present solutions to the rest of the class and discuss and refine solutions. • The ability to apply financial thinking to real life is important for everyone. • Costing and being able to monitor a budget has been identified as an important skill for work by ACME's Mathematical Needs in the Workplace report (2011). It can also be included in business qualifications at level 3.		
Competence statements	**Objectives**	**Resources**	**Examples of questions to promote thinking**
IQRf1-4 IQRf10, 11, 12, 14	***Core*** • Be able to decide what information is needed to address a financial situation. • Know how to obtain the necessary information. • Be able to carry out calculations based on the information to provide one or more possible solutions to the situation. • Be able to decide which, if any, of the solutions are appropriate. • Be able to work out the regular outgoing cost for a large financial decision. • Be able to find relevant information from tables. • Be able to use a spreadsheet to cost a project or business proposal, recognising that some costs are more variable than others over time. • Understand and use the language of finance. ***Extension*** • Investigate a financial situation of your own choice.	**Integral resources – OCR (MEI) Level 3 IQR** Financial problem solving 3: Costing and problem solving **Other resources** These resources are external to the Integral site. Interest rates and credit scores	• Show a budget for a year with 4 headings. What would the costs/incomes be after 3 months if the budget was on track? What if the amount under each heading was better than expected? Worse than expected? A mixture of better and worse than expected? • Ask students to swap figures with each other and decide which budget heading is doing best and worst after 3 months.

The small print

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