UNIVERSITY OF CAMBRIDGE

ECONOMICS ADMISSIONS ASSESSMENT (ECAA)

Content Specification

For assessment in 2019

Overview

The Economics Admissions Assessment consists of two sections:

Section 1: A multiple-choice assessment, comprising approximately 20 Problem Solving questions and approximately 15 Advanced Mathematics questions.

The time allowed for Section 1 is 80 minutes.

Section 2: An extended essay responding to an excerpt from a text.

The time allowed for Section 2 is 40 minutes.

The purpose of the Economics Admissions Assessment is to determine a candidate's potential to achieve in an academically demanding undergraduate degree course. Questions draw upon a candidate's ability to use and apply their reasoning and mathematical knowledge, but require their application in possibly unfamiliar contexts. The assessment is designed to be challenging in order to differentiate effectively between able applicants, including those who might have achieved the highest possible grades in school examinations.

Format

In Section 1, there are approximately 35 multiple-choice questions: about 20 Problem Solving questions and about 15 Advanced Mathematics questions. The Problem Solving questions will be presented first, followed by the Advanced Mathematics questions.

Candidates will have 80 minutes in total to complete Section 1. It is strongly recommended that candidates divide this time evenly between the Problem Solving questions and the Advanced Mathematics questions: 40 minutes on the 20 Problem Solving questions and 40 minutes on the 15 Advanced Mathematics questions.

This section will require a soft (HB) pencil and an eraser.

Calculators and dictionaries may NOT be used.

Candidates will be issued with an answer sheet on which to indicate their answers.

Full instructions for Section 1 will be given at the start of the assessment.

Candidates will have 40 minutes in total to complete Section 2. Candidates will be asked to read a short passage of 1-2 pages and then to write an essay in answer to a question, drawing on the material in the passage and any other ideas that they consider relevant.

Candidates will require a pen for this section, and will be issued with an answer booklet in which they will be required to write out their answer.

Calculators and dictionaries may NOT be used.

Full instructions for Section 2 will be given at the start of the assessment.

Content

Section 1

Section 1 of the Economics Admissions Assessment requires an ability to solve problems, and a knowledge of advanced mathematics. The requirements for each of these are summarised in Appendix 1 Parts A and B, respectively.

Examples of Problem Solving questions from Section 1 are given in Appendix 1 Part A.

An example of an Advanced Mathematics multiple-choice question from Section 1 is given in Appendix 2.

Section 2

Section 2 will relate to a topic of economic interest (broadly defined). This section of the assessment does not require any knowledge of the specific techniques of economic analysis or factual information about the economy of a particular country.

An example of an essay question from Section 2 is given in Appendix 2.

Scoring

In Section 1, each correct answer will score 1 mark. No marks are deducted for incorrect answers. The marks for each sub-section – Problem Solving and Advanced Mathematics – will be equally weighted and reported as **separate** totals. Candidates are strongly recommended to split their time equally between the two sub-sections, approximately 40 minutes for each.

In Section 2, the candidate’s essay will be assessed by taking into account the quality of the candidate’s reasoning, and their ability to construct a reasoned, insightful and logically consistent argument with clarity and precision.

APPENDIX 1: ASSESSMENT CONTENT

The material that follows outlines the knowledge and skills assessed in Section 1 of the Economics Admissions Assessment.

Part A outlines the skills expected of candidates for the Problem Solving questions in Section 1.

Part B outlines the knowledge expected of candidates for the Advanced Mathematics questions in Section 1.

Part A: Problem Solving

Problem Solving involves reasoning using numerical and spatial skills. The Problem Solving questions in the assessment are of three types, each assessing a key aspect of insight into unfamiliar problems. The three types of question are: Relevant Selection, Finding Procedures, and Identifying Similarity. Although most questions fall into one category, some questions fit into more than one of the categories.

The following examples show the three types of Problem Solving question in the assessment.

Example 1: Relevant Selection

Very often, a real-world problem will be overloaded with information, much of which is unimportant. The first step in solving the problem is to decide which bits of the information available are important. It may be that the question has presented you with information which is not important, perhaps redundant, and possibly distracting. This type of question demands Relevant Selection, in which the task is to select only that information that is necessary and helpful in finding a solution.

The following table gives figures for the percentage growth of labour productivity per person per year in various countries during three periods.

	Period 1	Period 2	Period 3
Japan	8.5	3.0	3.2
France	5.4	3.0	2.6
United Kingdom	3.6	1.5	2.4
Belgium	3.3	2.8	2.3
Sweden	4.1	1.5	1.8
Denmark	4.3	2.6	1.7
Italy	6.3	3.0	1.6
Netherlands	4.8	2.7	1.6
Germany	4.5	3.1	1.6
United States	2.2	0.0	0.8

Which country's percentage growth per year was greater than half of its Period 1 level in both Periods 2 and 3?

A Belgium

B Denmark

C France

D Germany

E United Kingdom

For this question, you need first to be clear what you need to do to find the answer: you must identify which row of the table contains numbers in the 'Period 2' and 'Period 3' columns that are more than half the number in the 'Period 1' column.

By quickly comparing the 'Period 1' and 'Period 2' columns, you can eliminate all but France, Belgium, Denmark, Netherlands and Germany. By comparing 'Period 1' and 'Period 3', you can eliminate all but Belgium. So the correct answer is option **A**.

Example 2: Finding Procedures

Sometimes you will find that even if you have selected all the relevant information, no solution presents itself. Questions of this type often provide you with very little information, all of which may be needed in order to solve the problem. You then have to find a method or procedure which you can use to generate a solution. Typically, you will have three or four numbers that have to be operated on. This aspect of Problem Solving is called Finding Procedures.

> The 400 seats in a parliament are divided amongst five political parties. No two parties have the same number of seats, and each has at least 20.
>
> What is the largest number of seats that the third largest party can have?
>
> **A** 22
>
> **B** 118
>
> **C** 119
>
> **D** 120
>
> **E** 121

Five parties share 400 seats. For the third largest party to have the maximum number of seats, the other parties must have the minimum number, whilst still meeting the other conditions set out in the question. So the fourth and fifth largest parties will have 21 and 20 seats, respectively. This leaves 359 seats to be divided between the three largest parties.

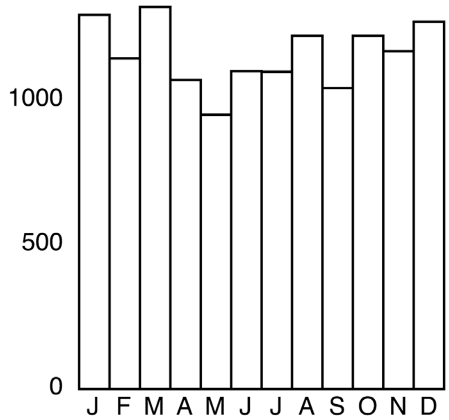
For the third largest party to have as many seats as possible, the other two must have only slightly more seats. If we divide the remaining 359 seats as nearly as possible into thirds, we get: 1st = 120; 2nd = 120; 3rd = 119. However, this violates the condition that no two parties have the same number of seats. To avoid this, one of the seats of the third largest party must be transferred to the largest party.

This gives: 1st = 121; 2nd = 120; 3rd = 118; 4th = 21; 5th = 20. The correct answer is option **B**.

Example 3: Identifying Similarity

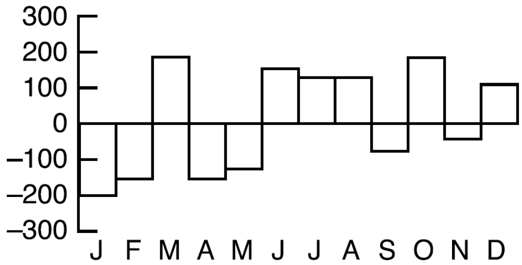
These questions are about being able to recognise data in a different form to that presented. The data is often presented in two different forms such as a table and then some graphs. It may also include spatial reasoning.

The graph below shows a person's bank balance at the end of each month in a year.

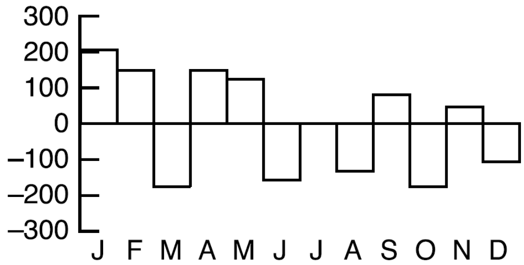


Which one of the following graphs could show the actual change in the bank balance each month?

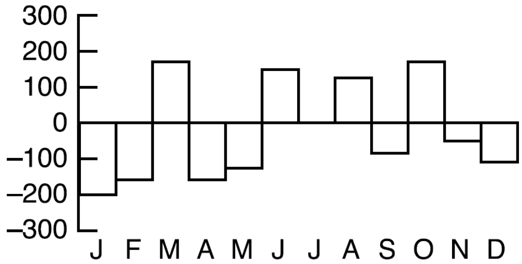
A



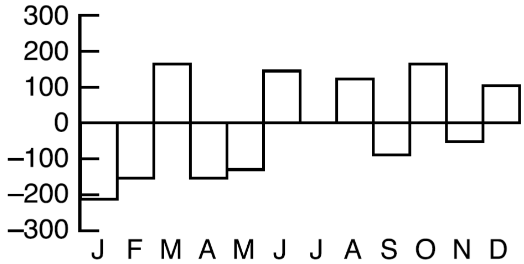
B



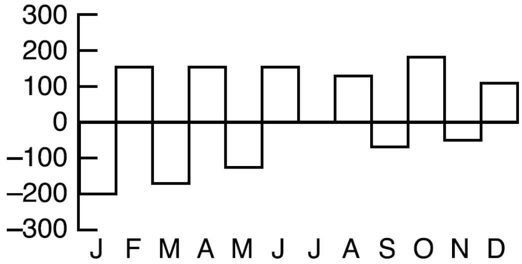
C



D



E



To solve this problem, you must first be clear about how the two types of graph represent the same information. The main graph shows the balance at the end of each month; the graphs in the options show us the *change* in the balance during each month. So, for example, the bar for February in the options represents the difference between the bars for January and February in the main graph.

In the main graph, the balance goes down between the end of January and the end of February, so the bar for February in the options should be negative. A comparison of the options shows that this is true only for options A, C and D, and so options B and E can be excluded. By comparing the values for each month in this way, you should find that the correct answer is option **D**.

Part B: Advanced Mathematics for Economics

The material that follows outlines the mathematical knowledge assessed in Section 1 of the Economics Admissions Assessment.

The Advanced Mathematics questions will be primarily based around topics labelled **AE1-AE9**, but it will also be assumed that candidates are familiar with the background topics labelled **E1-E7**.

Throughout this specification, it should be assumed that, where mention is made of a particular quantity, knowledge of the SI unit of that quantity is also expected (including the relationship of the unit to other SI units through the equations linking their quantities).

Candidates will be expected to be familiar with the following SI prefixes when used in connection with any SI unit:

nano-	10^{-9}
micro-	10^{-6}
milli-	10^{-3}
centi-	10^{-2}
deci-	10^{-1}
kilo-	10^{3}
mega-	10^{6}
giga-	10^{9}

ADVANCED MATHEMATICS FOR ECONOMICS

AE1. Algebra and functions

AE1.1 Laws of indices for all rational exponents.

AE1.2 Use and manipulation of surds.

Simplifying expressions that contain surds, including rationalising the denominator.

For example: simplifying $\dfrac{\sqrt{5}}{3+2\sqrt{5}}$ and $\dfrac{3}{\sqrt{7}-2\sqrt{3}}$

AE1.3 Quadratic functions and their graphs; the discriminant of a quadratic function; completing the square; solution of quadratic equations.

AE1.4 Simultaneous equations: analytical solution by substitution, e.g. of one linear and one quadratic equation.

AE1.5 Solution of linear and quadratic inequalities.

AE1.6 Algebraic manipulation of polynomials, including:

a. expanding brackets and collecting like terms

b. factorisation and simple algebraic division (by a linear polynomial, including those of the form $ax + b$)

c. use of the Factor Theorem and the Remainder Theorem

AE2. Sequences and series

AE2.1 Sequences, including those given by a formula for the n^{th} term and those generated by a simple recurrence relation of the form $x_{n+1} = f(x_n)$

AE2.2 Arithmetic series, including the formula for the sum of the first n natural numbers.

AE2.3 The sum of a finite geometric series.

The sum to infinity of a convergent geometric series, including the use of $|r| < 1$

AE2.4 Binomial expansion of $(1 + x)^n$ for positive integer n.

The notations $n!$ and $\dbinom{n}{r}$.

AE3. Coordinate geometry in the (x, y)-plane

AE3.1 Equation of a straight line, including:

a. $y - y_1 = m(x - x_1)$

b. $ax + by + c = 0$

Conditions for two straight lines to be parallel or perpendicular to each other.

Finding equations of straight lines given information in various forms.

AE3.2 Coordinate geometry of the circle, using the equation of a circle in the forms:

a. $(x-a)^2+(y-b)^2=r^2$

b. $x^2+y^2+cx+dy+e=0$

AE4. Trigonometry

AE4.1 The sine and cosine rules, and the area of a triangle in the form $\frac{1}{2}ab\sin C$.

The sine rule includes an understanding of the 'ambiguous' case (angle–side–side).

Problems might be set in 2 or 3 dimensions.

AE4.2 The sine, cosine and tangent functions; their graphs, symmetries, and periodicity.

AE4.3 Knowledge and use of the equations:

a. $\tan\theta=\dfrac{\sin\theta}{\cos\theta}$

b. $\sin^2\theta+\cos^2\theta=1$

AE5. Exponentials and logarithms

AE5.1 $y=a^x$ and its graph, for simple positive values of a.

AE5.2 Laws of logarithms:

a. $a^b=c \Leftrightarrow b=\log_a c$

b. $\log_a x+\log_a y=\log_a(xy)$

c. $\log_a x-\log_a y=\log_a\left(\dfrac{x}{y}\right)$

d. $k\log_a x=\log_a(x^k)$

including the special cases:

e. $\log_a\left(\dfrac{1}{x}\right)=-\log_a x$

f. $\log_a a=1$

Questions requiring knowledge of the change of base formula will not be set.

AE5.3 The solution of equations of the form $a^x=b$, and equations which can be reduced to this form, including those that need prior algebraic manipulation.

For example: $3^{2x}=4$ and $25^x-3\times5^x+2=0$

AE6. Differentiation

AE6.1 The derivative of $f(x)$ as the gradient of the tangent to the graph $y = f(x)$ at a point.

a. Interpretation of a derivative as a rate of change.

b. Second-order derivatives.

c. Knowledge of notation: $\frac{\mathrm{d}y}{\mathrm{d}x}$, $\frac{\mathrm{d}^2 y}{\mathrm{d}x^2}$, $f'(x)$, and $f''(x)$

Differentiation from first principles is excluded.

AE6.2 Differentiation of x^n for rational n, and related sums and differences. This might require some simplification before differentiating.

For example, the ability to differentiate an expression such as $\frac{(3x+2)^2}{x^{\frac{1}{2}}}$

AE6.3 Applications of differentiation to gradients, tangents, normals, stationary points (maxima and minima only). Points of inflexion will not be examined.

AE7. Integration

AE7.1 Definite integration as related to the 'area between a curve and an axis'. The difference between finding a definite integral and finding the area between a curve and an axis is expected to be understood.

AE7.2 Finding definite and indefinite integrals of x^n for n rational, $n \neq 1$, and related sums and differences, including expressions which require simplification prior to integrating.

For example: $\int (x+2)^2 \,\mathrm{d}x$ and $\int \frac{(3x-5)^2}{x^{\frac{1}{2}}} \,\mathrm{d}x$

AE7.3 An understanding of the Fundamental Theorem of Calculus and its significance to integration. Simple examples of its use may be required in the forms:

a. $\int_a^b f(x)\,\mathrm{d}x = F(b) - F(a)$, where $F'(x) = f(x)$

b. $\frac{\mathrm{d}}{\mathrm{d}x}\int_a^x f(x)\,\mathrm{d}x = f(x)$

AE7.4 Combining integrals with either equal or contiguous ranges.

For example: $\int_2^5 f(x)\,\mathrm{d}x + \int_2^5 g(x)\,\mathrm{d}x = \int_2^5 [f(x) + g(x)]\,\mathrm{d}x$

$$\int_2^4 f(x)\,\mathrm{d}x + \int_4^3 f(x)\,\mathrm{d}x = \int_2^3 f(x)\,\mathrm{d}x$$

AE7.5 Solving differential equations of the form $\frac{\mathrm{d}y}{\mathrm{d}x} = f(x)$

AE8. Graphs of functions

AE8.1 Recognise and be able to sketch the graphs of common functions that appear in this specification: these include lines, quadratics, cubics, trigonometric functions, logarithmic functions, exponential functions.

AE8.2 Knowledge of the effect of simple transformations on the graph of $y = f(x)$ with positive or negative value of a as represented by:

a. $y = af(x)$

b. $y = f(x) + a$

c. $y = f(x + a)$

d. $y = f(ax)$

Compositions of these transformations.

AE8.3 Understand how altering the values of m and c affects the graph of $y = mx + c$

AE8.4 Understand how altering the values of a, b and c in $y = a(x + b)^2 + c$ affects the corresponding graph.

AE8.5 Use differentiation to help determine the shape of the graph of a given function, including:

a. finding stationary points (excluding inflexions).

b. when the graph is increasing or decreasing.

AE8.6 Use algebraic techniques to determine where the graph of a function intersects the coordinate axes; appreciate the possible numbers of real roots that a general polynomial can possess.

AE8.7 Geometric interpretation of algebraic solutions of equations; relationship between the intersections of two graphs and the solutions of the corresponding simultaneous equations.

AE9. The logic of arguments

AE9.1 Understand and be able to use mathematical logic in simple situations:

a. the terms ***true*** and ***false***
b. the terms ***and***, ***or*** (meaning **inclusive or**), and ***not***
c. statements of the form:
   i. **if A then B**
   ii. **A if B**
   iii. **A only if B**
   iv. **A if and only if B**

AE9.2 Understand and use the terms ***necessary*** and ***sufficient***.

AE9.3 Understand and use the terms ***for all***, ***for some*** (meaning ***for at least one***), and ***there exists***.

AE9.4 Be able to negate statements that use any of the terms in this section.

MATHEMATICS FOR ECONOMICS

E1. Units

E1.1 Use standard units of mass, length, time, money and other measures.

Use compound units such as speed, rates of pay, unit pricing, density and pressure, including using decimal quantities where appropriate.

E1.2 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.

E2. Number

E2.1 Order positive and negative integers, decimals and fractions.

Understand and use the symbols: $=$, $\neq$, $<$, $>$, $\leq$, $\geq$.

E2.2 Apply the four operations (addition, subtraction, multiplication and division) to integers, decimals, simple fractions (proper and improper) and mixed numbers – any of which could be positive or negative.

Understand and use place value.

E2.3 Use the concepts and vocabulary of prime numbers, factors (divisors), multiples, common factors, common multiples, highest common factor, lowest common multiple, and prime factorisation (including use of product notation and the unique factorisation theorem).

E2.4 Recognise and use relationships between operations, including inverse operations.

Use cancellation to simplify calculations and expressions.

Understand and use the convention for priority of operations, including brackets, powers, roots and reciprocals.

E2.5 Apply systematic listing strategies. (For instance, if there are m ways of doing one task and for each of these tasks there are n ways of doing another task, then the total number of ways the two tasks can be done in order is $m \times n$ ways.)

E2.6 Use and understand the terms: *square*, *positive* and *negative square root*, *cube* and *cube root*.

E2.7 Use index laws to simplify numerical expressions, and for multiplication and division of integer, fractional and negative powers.

E2.8 Interpret, order and calculate with numbers written in standard index form (standard form); numbers are written in standard form as $a \times 10^n$, where $1 \leq a < 10$ and n is an integer.

E2.9 Convert between terminating decimals, percentages and fractions.

Convert between recurring decimals and their corresponding fractions.

E2.10 Use fractions, decimals and percentages interchangeably in calculations.

Understand equivalent fractions.

E2.11 Calculate exactly with fractions, surds and multiples of π.

Simplify surd expressions involving squares, e.g. $\sqrt{12} = \sqrt{4 \times 3} = \sqrt{4}\sqrt{3} = 2\sqrt{3}$, and rationalise denominators; for example, candidates could be asked to rationalise expressions such as: $\frac{3}{\sqrt{7}}$, $\frac{5}{3+2\sqrt{5}}$, $\frac{7}{2-\sqrt{3}}$, $\frac{3}{\sqrt{5}-\sqrt{2}}$.

E2.12 Calculate with upper and lower bounds, and use in contextual problems.

E2.13 Round numbers and measures to an appropriate degree of accuracy, e.g. to a specified number of decimal places or significant figures.

Use inequality notation to specify simple error intervals due to truncation or rounding.

E2.14 Use approximation to produce estimates of calculations, including expressions involving π or surds.

E3. Ratio and proportion

E3.1 Understand and use scale factors, scale diagrams and maps.

E3.2 Express a quantity as a fraction of another, where the fraction is less than 1 or greater than 1.

E3.3 Understand and use ratio notation.

E3.4 Divide a given quantity into two (or more) parts in a given *part* **:** *part* ratio.

Express the division of a quantity into two parts as a ratio.

E3.5 Apply ratio to real contexts and problems, such as those involving conversion, comparison, scaling, mixing and concentrations.

Express a multiplicative relationship between two quantities as a ratio or a fraction.

E3.6 Understand and use proportion.

Relate ratios to fractions and to linear functions.

E3.7 Identify and work with fractions in ratio problems.

E3.8 Define percentage as ‘number of parts per hundred’.

Interpret percentages and percentage changes as a fraction or a decimal, and interpret these multiplicatively.

Express one quantity as a percentage of another.

Compare two quantities using percentages.

Work with percentages greater than 100%.

Solve problems involving percentage change, including percentage increase/decrease, original value problems and simple interest calculations.

E3.9 Understand and use direct and inverse proportion, including algebraic representations.

Recognise and interpret graphs that illustrate direct and inverse proportion.

Set up, use and interpret equations to solve problems involving direct and inverse proportion (including questions involving integer and fractional powers).

Understand that x is inversely proportional to y is equivalent to x is proportional to $\frac{1}{y}$.

E3.10 Compare lengths, areas and volumes using ratio notation.

Understand and make links to similarity (including trigonometric ratios) and scale factors.

E3.11 Set up, solve and interpret the answers in growth and decay problems, including compound interest, and work with general iterative processes.

E4. Algebra

E4.1 Understand, use and interpret algebraic notation; for instance: ab in place of $a \times b$; $3y$ in place of $y+y+y$ and $3 \times y$; a^2 in place of $a \times a$; a^3 in place of $a \times a \times a$; a^2b in place of $a \times a \times b$; $\frac{a}{b}$ in place of $a \div b$.

E4.2 Use index laws in algebra for multiplication and division of integer, fractional, and negative powers.

E4.3 Substitute numerical values into formulae and expressions, including scientific formulae.

Understand and use the concepts and vocabulary: *expressions*, *equations*, *formulae*, *identities*, *inequalities*, *terms* and *factors*.

E4.4 Collect like terms, multiply a single term over a bracket, take out common factors, and expand products of two or more binomials.

E4.5 Factorise quadratic expressions of the form x^2+bx+c, including the difference of two squares.

Factorise quadratic expressions of the form ax^2+bx+c, including the difference of two squares.

E4.6 Simplify expressions involving sums, products and powers, including the laws of indices.

Simplify rational expressions by cancelling, or factorising and cancelling.

Use the four rules on algebraic rational expressions.

E4.7 Rearrange formulae to change the subject.

E4.8 Understand the difference between an equation and an identity.

Argue mathematically to show that algebraic expressions are equivalent.

E4.9 Work with coordinates in all four quadrants.

E4.10 Identify and interpret gradients and intercepts of linear functions ($y = mx + c$) graphically and algebraically.

Identify pairs of parallel lines and identify pairs of perpendicular lines, including the relationships between gradients.

Find the equation of the line through two given points, or through one point with a given gradient.

E4.11 Identify and interpret roots, intercepts and turning points of quadratic functions graphically.

Deduce roots algebraically, and turning points by completing the square.

E4.12 Recognise, sketch and interpret graphs of:

a. linear functions
b. quadratic functions
c. simple cubic functions
d. the reciprocal function: $y = \frac{1}{x}$ with $x \neq 0$
e. the exponential function: $y = k^x$ for positive values of k
f. trigonometric functions (with arguments in degrees): $y = \sin x$, $y = \cos x$, $y = \tan x$ for angles of any size

E4.13 Interpret graphs (including reciprocal graphs and exponential graphs) and graphs of non-standard functions in real contexts to find approximate solutions to problems, such as simple kinematic problems involving distance, speed and acceleration.

E4.14 Calculate or estimate gradients of graphs and areas under graphs (including quadratic and other non-linear graphs) and interpret results in cases such as distance–time graphs, speed–time graphs and graphs in financial contexts.

E4.15 Set up and solve, both algebraically and graphically, simple equations including simultaneous equations involving two unknowns; this may include one linear and one quadratic equation.

Solve two simultaneous equations in two variables (linear/linear or linear/quadratic) algebraically.

Find approximate solutions using a graph.

Translate simple situations or procedures into algebraic expressions or formulae; for example, derive an equation (or two simultaneous equations), solve the equation(s) and interpret the solution.

E4.16 Solve quadratic equations (including those that require rearrangement) algebraically by factorising, by completing the square, and by using the quadratic formula.

Know the quadratic formula: $x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$

Find approximate solutions of quadratic equations using a graph.

E4.17 Solve linear inequalities in one or two variables.

Represent the solution set on a number line, or on a graph, or in words.

E4.18 Generate terms of a sequence using term-to-term or position-to-term rules.

E4.19 Deduce expressions to calculate the n^{th} term of linear or quadratic sequences.

E5. Geometry

E5.1 Use conventional terms and notation: points, lines, line segments, vertices, edges, planes, parallel lines, perpendicular lines, right angles, subtended angles, polygons, regular polygons and polygons with reflection and/or rotational symmetries.

E5.2 Recall and use the properties of angles at a point, angles on a straight line, perpendicular lines, and opposite angles at a vertex.

Understand and use the angle properties of parallel lines, intersecting lines, triangles and quadrilaterals.

Calculate and use the sum of the interior angles, and the sum of the exterior angles, of polygons.

E5.3 Derive and apply the properties and definitions of special types of quadrilaterals, including square, rectangle, parallelogram, trapezium, kite and rhombus.

Derive and apply the properties and definitions of various types of triangle and other plane figures using appropriate language.

E5.4 Apply angle facts, triangle congruence, similarity, and properties of quadrilaterals to results about angles and sides.

E5.5 Know and use the formula for Pythagoras' theorem: $a^2 + b^2 = c^2$

Use Pythagoras' theorem in both 2 and 3 dimensions.

E5.6 Identify and use conventional circle terms: *centre*, *radius*, *chord*, *diameter*, *circumference*, *tangent*, *arc*, *sector* and *segment* (including the use of the terms *minor* and *major* for arcs, sectors and segments).

E5.7 Solve geometrical problems on 2-dimensional coordinate axes.

E5.8 Know the terminology *faces*, *surfaces*, *edges* and *vertices* when applied to cubes, cuboids, prisms, cylinders, pyramids, cones, spheres and hemispheres.

E6. Statistics

E6.1 Interpret and construct tables, charts and diagrams, including:

a. two-way tables, frequency tables, bar charts, pie charts and pictograms for categorical data
b. vertical line charts for ungrouped discrete numerical data
c. tables and line graphs for time series data

Know the appropriate use of each of these representations.

E6.2 Interpret and construct diagrams for grouped discrete data and continuous data:

a. histograms with equal and unequal class intervals
b. cumulative frequency graphs

Know the appropriate use of each of these diagrams.

Understand and use the term *frequency density*.

E6.3 Calculate the *mean*, *mode*, *median* and *range* for ungrouped data.

Find the modal class; calculate estimates of the range, mean and median for grouped data, and understand why these are estimates.

Describe a population using statistics.

Make simple comparisons.

Compare data sets using like-for-like summary values.

Understand the advantages and disadvantages of summary values.

Calculate estimates of mean, median, mode, range, quartiles and interquartile range from graphical representation of grouped data.

Use the median and interquartile range to compare distributions.

E6.4 Use and interpret scatter graphs of bivariate data.

Recognise correlation, and know that it does not indicate causation.

Draw estimated lines of best fit.

Interpolate and extrapolate apparent trends whilst knowing the dangers of so doing.

E7. Probability

E7.1 Analyse the frequency of outcomes of probability experiments using tables and frequency trees.

E7.2 Apply ideas of randomness, fairness and equally likely events to calculate expected outcomes of multiple future experiments.

Understand that if an experiment is repeated, the outcome may be different.

E7.3 Relate relative expected frequencies to theoretical probability, using appropriate language and the ‘0 to 1’ probability scale.

E7.4 Apply the property that the probabilities of an exhaustive set of outcomes sum to one.

Apply the property that the probabilities of an exhaustive set of mutually exclusive events sum to one.

E7.5 Enumerate sets and combinations of sets systematically, using tables, grids, Venn diagrams and tree diagrams. Candidates are not expected to know formal set theory notation.

E7.6 Construct theoretical possibility spaces for single and combined experiments with equally likely outcomes, and use these to calculate theoretical probabilities.

E7.7 Know when to add or multiply two probabilities, and understand conditional probability.

Calculate and interpret conditional probabilities through representation using expected frequencies with two-way tables, tree diagrams and Venn diagrams.

Understand the use of tree diagrams to represent outcomes of combined events:

a. when the probabilities are independent of the previous outcome
b. when the probabilities are dependent on the previous outcome

APPENDIX 2: EXAMPLE QUESTIONS

Section 1, Part B: Advanced Mathematics

What is the smallest possible value of $\int_0^1 (x-a)^2\,\mathrm{d}x$ as a varies?

A $\frac{1}{12}$

B $\frac{1}{3}$

C $\frac{1}{2}$

D $\frac{7}{12}$

E 2

The correct answer is option **A**.

Section 2: Essay question and text

Read the extract taken from John Kenneth Galbraith's *The Affluent Society* (1958) and then answer the following:

What is understood by "the Conventional Wisdom"? Discuss an example of an idea which qualifies as conventional wisdom.

The Concept of the Conventional Wisdom

THE FIRST requirement for an understanding of contemporary economic and social life is a clear view of the relation between events and the ideas which interpret them. For each of these has a life of its own and, much as it may seem a contradiction in terms, each is capable for a considerable period of pursuing an independent course.

The reason is not difficult to discover. Economic like other social life does not conform to a simple and coherent pattern. On the contrary, it often seems incoherent, inchoate and intellectually frustrating. But one must have an explanation or interpretation of economic behavior. Neither man's curiosity nor his inherent ego allows him to remain contentedly oblivious to anything that is so close to his life.

Because economic and social phenomena are so forbidding, or at least so seem, and because they yield few hard tests of what exists and what does not, they afford to the individual a luxury not given by physical phenomena. Within a considerable range, he is permitted to believe what he pleases. He may hold whatever view of this world he finds most agreeable or otherwise to his taste.

As a consequence, in the interpretation of all social life, there is a persistent and never-ending competition between what is right and what is merely acceptable. In this competition, while a strategic advantage lies with what exists, all tactical advantage is with the acceptable. Audiences of all kinds most applaud what they like best. And in social comment, the test of audience approval, far more than the test of truth, comes to influence comment. The speaker or writer who addresses his audience with the proclaimed intent of telling the hard, shocking facts invariably goes on to expound what the audience most wants to hear.

Just as truth ultimately serves to create a consensus, so in the short run does acceptability. Ideas come to be organized around what the community as a whole or particular audiences find acceptable. And as the laboratory worker devotes himself to discovering scientific verities, so the ghost writer and the public relations man concern themselves with identifying the acceptable. If their clients are rewarded with applause, these artisans are deemed qualified in their craft. If not, they have failed. By sampling audience reaction in advance, or by pretesting speeches, articles and other communications, the risk of failure can now be greatly minimized.

Numerous factors contribute to the acceptability of ideas. To a very large extent, of course, we associate truth with convenience – with what most closely accords with self-interest and personal well-being or promises best to avoid awkward effort or unwelcome dislocation of life. We also find highly acceptable what contributes most to self-esteem. Speakers before the United States Chamber of Commerce rarely denigrate the businessman as an economic force. Those who appear before the AFL-CIO are prone to identify social progress with a strong trade union movement. But perhaps most important of all, people approve most of what they best understand. As just noted, economic and social behavior are complex, and to comprehend their character is mentally tiring. Therefore we adhere, as though to a raft, to those ideas which represent our understanding. This is a prime manifestation of vested interest. For a vested interest in understanding is more preciously guarded than any other treasure. It is why men react, not infrequently with something akin to religious passion, to the defense of what they have so laboriously learned. Familiarity may breed contempt in some areas of human behavior, but in the field of social ideas it is the touchstone of acceptability.

Because familiarity is such an important test of acceptability, the acceptable ideas have great stability. They are highly predictable. It will be convenient to have a name for the ideas which are esteemed at any time for their acceptability, and it should be a term that emphasizes this predictability. I shall refer to these ideas henceforth as the Conventional Wisdom.

[Quoted from: *The Affluent Society* (1958) by J.K. Galbraith]

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