UNIVERSITY OF CAMBRIDGE

PSYCHOLOGICAL AND BEHAVIOURAL SCIENCES ADMISSIONS ASSESSMENT (PBSAA)

Content Specification

For assessment in 2019

Overview

The Psychological and Behavioural Sciences Admissions Assessment consists of two sections:

Section 1 consists of three parts. Candidates are required to answer **two** of these three parts:

- One compulsory part: Part A Thinking Skills
- One further part chosen from: Part B Mathematics and Biology
  or Part C Reading Comprehension

All questions in Section 1 are multiple choice.

The time allowed for Section 1 is 80 minutes.

Section 2 consists of four written tasks of which candidates should complete **one**.

The time allowed for Section 2 is 40 minutes.

The purpose of the Psychological and Behavioural Sciences Admissions Assessment is to determine a candidate's potential to achieve in an academically demanding undergraduate degree course. 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.

Calculators and dictionaries are **not** permitted for any part of this assessment.

Format

Section 1 consists of three parts. **Candidates will be required to answer Part A, and one further part chosen from B or C.** The three parts are as follows:

Part A Thinking Skills

Part B Mathematics and Biology

Part C Reading Comprehension

Part A (Thinking Skills) consists of 22 multiple-choice questions, of which 11 are Critical Thinking questions and 11 are Problem Solving questions.

Part B (Mathematics and Biology) consists of 30 multiple-choice questions, of which 15 are Mathematics and 15 are Biology. The questions in Part B assess a candidate's ability to use and apply their mathematical and biological knowledge.

Part C (Reading Comprehension) consists of 24 multiple-choice questions, and comprises three tasks.

The time allowed to complete Section 1 is 80 minutes and candidates should be careful to manage their time accordingly. Candidates are advised to spend approximately 40 minutes on Part A and 40 minutes on their other chosen part. The results for each part will be reported **separately**.

Example questions for Section 1 are given in Appendix 1.

Section 2 requires candidates to discuss a quotation. Candidates must discuss **one** from a choice of four. This section assesses each candidate's ability to think analytically and produce a coherent argument. The time allowed to complete Section 2 is 40 minutes.

Example questions for Section 2 are given in Appendix 2.

Content

Section 1

The questions in Section 1 will draw upon the knowledge and topics set out in the appropriate part of Appendix 1.

Part A (Thinking Skills) will consist of both Critical Thinking and Problem Solving multiple-choice questions, which are described in Appendix 1 Part A.

Part B (Mathematics and Biology) will assume knowledge of the mathematical and biological content of Appendix 1 Part B.

Part C (Reading Comprehension) will consist of three tasks, each based around text excerpts. The questions will not require any specialist or background knowledge beyond the information contained in the texts. Further details of the format of these tasks are given in Appendix 1 Part C.

Example questions for each part of Section 1 are given in the corresponding parts of Appendix 1.

Section 2

The questions in Section 2 require candidates to discuss one quotation from a choice of four. Further details of what is expected of candidates in Section 2 are given in Appendix 2.

Scoring

In Section 1, each correct answer will score 1 mark. No marks will be deducted for incorrect answers. Results for each part will be reported **separately**.

In Section 2, candidates' answers will be assessed taking into account how well they have:

- thought analytically and produced a coherent argument, using relevant evidence.
- written with clarity and precision under time pressure.

APPENDIX 1: KNOWLEDGE AND SKILLS ASSUMED IN SECTION 1

Part A of this appendix gives an overview of the main skills assessed by the Thinking Skills part of Section 1. In addition to explanations of the Critical Thinking and Problem Solving skills that will be assessed, an example of each type of question has been included, together with an explanation of the correct answer.

Part B of this appendix outlines the mathematical and biological knowledge that the questions in the Mathematics and Biology part of Section 1 can draw upon. Some example questions for this part are given at the end of this appendix.

Part C of this appendix outlines the structure of the types of tasks assessed in the Reading Comprehension part of Section 1. Some example questions for this part are given at the end of this appendix.

Part A: Thinking Skills

Part A will consist of both Critical Thinking and Problem Solving multiple-choice questions. In each case, a stimulus is presented, which is followed by the question and five options. One of the options is the correct answer and the remaining four options are incorrect.

The skill of Critical Thinking is essential to any academic study and often involves considering an argument put forward to promote or defend a particular point of view. It is important in higher education to understand the arguments presented by others and to be able to assess whether the arguments establish their claims.

The skill of Problem Solving is important as many problems encountered in academic and professional work are novel, and no ready ‘off the peg’ solution is available. The task is to find or create a solution using the information available.

In the case of the Critical Thinking questions, the stimulus is a passage of text, often one that puts forward an argument to promote or defend a particular point of view. In Problem Solving questions, the stimulus may include a diagram, a table of information, or a graph. The multiple-choice options may also be graphs or diagrams.

Critical Thinking

Critical Thinking involves reasoning using everyday written language. Questions focus on the skills involved in understanding and evaluating arguments. These include: summarising conclusions, identifying assumptions, assessing the impact of additional evidence, detecting reasoning errors and applying principles. On the pages that follow, one example of each of the five Critical Thinking question types in the assessment is given.

Example 1: Summarising the main conclusion

In this type of question you have to judge which one of the statements **A** to **E** best expresses the main conclusion of the argument. So the important first step is to read the passage carefully and pick out the sentence that is the conclusion. Remember that the conclusion can appear anywhere within an argument, not necessarily at the end. Remember also that what you are looking for is the statement that follows from or is supported by the rest of the passage.

Vegetarian food can be healthier than a traditional diet. Research has shown that vegetarians are less likely to suffer from heart disease and obesity than meat eaters. Concern has been expressed that vegetarians do not get enough protein in their diet but it has been demonstrated that, by selecting foods carefully, vegetarians are able to amply meet their needs in this respect.

Which one of the following best expresses the main conclusion of the above argument?

A A vegetarian diet can be better for health than a traditional diet.

B Adequate protein is available from a vegetarian diet.

C A traditional diet is very high in protein.

D A balanced diet is more important for health than any particular food.

E Vegetarians are unlikely to suffer from heart disease and obesity.

A passage may have an intermediate conclusion which is just one of the steps in the reasoning towards the main conclusion. Be careful to check this. If a sentence appears to be a conclusion, but is used as a reason to support some other statement in the passage, then it will not be the main conclusion. Do not worry about whether the information in the passage is true. Just ask yourself: 'If these reasons were true, would they give me good reason to accept the sentence I have identified as the main conclusion?'.

What does this argument seem to be trying to get you to accept? It seems to be trying to persuade you that vegetarian food can be healthier than a traditional diet (the first sentence). If you think this is the main conclusion, you should then check whether the rest of the passage gives you reason to believe this. Two reasons are given:

- Vegetarians are less likely to suffer from heart disease and obesity than meat eaters.
- A vegetarian diet can contain sufficient protein.

You may not know whether these reasons are true but, if they were true, they would indicate that vegetarian food is healthier in one respect than a diet which includes meat, and that a vegetarian diet does not necessarily have the disadvantage to health (providing insufficient protein) which some may think. So it seems clear that the first sentence of the passage is being offered as a conclusion.

The correct answer is option **A**.

Example 2: Identifying an assumption

Questions of this type ask you to identify an assumption in an argument. An assumption is something that is not stated in the argument but that is taken for granted in order to draw the conclusion. So you need first to identify the conclusion of the argument. Then look for the reasoning the argument gives to support this conclusion, and think about any important point that is not actually stated in the reasoning.

People who write books revealing the inner workings of the secret service have usually been dismissed from the service or have retired with a sense of grievance against it. The result is that only the seedy side of the secret service is exposed. This is partly because those who would paint a more favourable picture are unwilling to flout the legal restrictions placed on all who have been employed in the secret service, and partly because the records of the organisations are not available to outsiders.

Which one of the following is an underlying assumption of the above argument?

A The records of the secret service are readily available to its former employees.

B The work of the secret service is undervalued as a result of publication of distorted accounts of its working.

C The seedy side of the secret service is of minor significance compared with the important work it carries out.

D Legal restrictions against revealing the inner workings of the secret service do not apply to those who have been dismissed.

E Those who have a grievance against the secret service are either unable or unwilling to give a balanced account of its workings.

The answer to this question is option **E**. The conclusion is that only the seedy side of the secret service is exposed. The reasons given for this are that:

- the records of the secret service are not generally available.
- there are legal restrictions on employees of the secret service which forbid them from writing about it.
- the only employees or ex-employees who would ignore this restriction are those with a sense of grievance against the secret service.

From these reasons, it would not follow that only the seedy side of the secret service was exposed if those with a grievance were able and willing to give a balanced account. So it must be assumed that either they are not able or they are not willing to do so.

A is not assumed. The passage says that the records are not available to outsiders. But ex-employees may or may not have access to records. We do not need to assume that they do have access in order to conclude that, when they write about the secret service, they reveal only its seedy side.

B is not assumed, because it goes further than the passage. It considers the effects of publications about the secret service. But what we are looking for as an assumption is something which helps to support the conclusion of the passage.

C is not assumed, because the passage says nothing about the importance of the work carried out by the secret service. It does suggest that there is another side to the secret service, besides the seedy side, but no assumptions can be made about which is more important.

D is not assumed, because the passage says that the legal restrictions apply to ‘all who have been employed’, and this must include those who have been dismissed.

Example 3: Assessing the impact of additional evidence

This type of question will typically ask you to consider what would weaken or strengthen an argument. You need first to be clear about what the argument is trying to establish. Work out what the conclusion is, and then consider what effect each of the possible answers would have on the conclusion.

Polar bears in captivity frequently engage in obsessive patterns of behaviour, pacing back and forth on the same spot, swinging their heads from side to side, and showing other signs of stress. They do this even when their living areas are quite spacious. What this shows is that conditions of captivity are not a satisfactory substitute for the natural environment of the polar bear species.

Which one of the following, if true, would most weaken the above argument?

A Polar bears are especially ill-suited to a life in captivity.

B Many polar bears in the wild engage in obsessive patterns of behaviour.

C Polar bears in captivity are much better fed than those living in the wild.

D Polar bears in the wild cover many miles a day when they are hunting for food.

E Polar bears that have been reared in captivity are incapable of surviving in the wild.

The answer is option **B**. The conclusion of the argument is that the obsessive behaviour of polar bears in zoos shows that conditions of captivity are not a satisfactory substitute for the polar bear's natural environment. But if **B** is true, that is, if polar bears in the wild behave in the same way as those in captivity, then the behaviour of those in captivity cannot be taken as good evidence that the conditions of captivity are unsatisfactory.

A does not weaken the argument. If polar bears are ill-suited to a life in captivity, it follows that captivity is not a satisfactory substitute for their natural environment. So **A** strengthens the argument.

C does not weaken the argument, even though it suggests that polar bears might be better off in one respect in captivity (that is, better fed). Captivity might nevertheless lead to stress that is not suffered by polar bears in the wild.

D does not weaken the argument, because, even if polar bears cover many miles per day in the wild, pacing around in captivity may not be a satisfactory substitute for this freedom to roam.

E does not weaken the argument, because the conclusion is about the best environment for the polar bear species. Information about the best environment for those polar bears which have been reared in captivity cannot weaken this general conclusion about the species as a whole.

Example 4: Detecting reasoning errors

This type of question asks you to identify the flaw in the argument, which means that you must identify why the conclusion does not follow from the reasons that are given. So you need to be clear about what the conclusion is, and what reasons are meant to support it.

Some recent films have been very expensive to make, but have not been the big box-office hits that would have justified the expense. At the same time, there have been films made very cheaply which have been received with both huge critical and popular acclaim. Indeed, some directors who have made successful low-budget films have gone on to make unsuccessful but expensive films. It is obvious then that if directors want to make popular films, they should stick to low budgets.

Which one of the following is the best statement of the flaw in the argument above?

A Critics are often wrong in their predictions about the popularity of films.

B The cost of making a film is normally greater than its original budget.

C The cost of a film need not be the factor that determines its popularity.

D The popularity of a film would justify a high level of expense in making it.

E The public does not necessarily know whether a film has been expensive or cheap to make.

The answer is option **C**. The argument draws the conclusion that if directors want to make popular films, they should stick to low budgets. The reasoning offered in support of this is that:

- some recent films have been very expensive to make, but have not been successful enough to justify the expense.
- there have been films made very cheaply that have been very popular.
- some directors who have made successful low-budget films have gone on to make unsuccessful but expensive films.

But the conclusion does not follow, because the argument fails to establish a causal link between the cost of making a film and its popularity: it fails to consider high-budget films that have been popular and low-budget films that have been unpopular. **C** is the statement which best explains this.

A does not describe the flaw, because it simply states something that may be true but is of little relevance to the argument.

B does not describe the flaw, because the argument does not depend upon a comparison of original and final budgets.

D does not describe the flaw, because it states something that may be true but, if anything, contradicts the conclusion of the argument.

E does not describe the flaw, because it simply states something that may be true but is not relied upon by the argument when reaching the conclusion.

Example 5: Applying principles

In this type of question you are asked which statement illustrates the principle underlying the passage. A principle is a general recommendation, which in the passage will be applied to just one particular case, but which could also be applied to other cases. In order to answer this type of question, you must first identify this principle and then consider each of the options to see which one follows from that principle.

Smokers who suffer from heart disease which is caused by their smoking should not be allowed to get free health treatment. That is because this is an example of self-inflicted illness. Those whose actions have caused illness or injury to themselves should make a financial contribution to their treatment.

Which one of the following best illustrates the principle underlying the argument above?

A Children should get free dental treatment, even if they eat sweets which cause dental decay.

B Heart disease sufferers who can afford to pay for health treatment should not receive free treatment.

C Smokers who cannot afford to pay for healthcare should be allowed free treatment when they are ill.

D People who are injured in car accidents should receive free treatment regardless of whether they were wearing a seat belt.

E Motor cyclists whose head injuries are caused by not wearing a crash helmet should make a financial contribution to their treatment.

When you are asked which statement illustrates the principle underlying the passage, you must first identify this principle. For example, someone might use the principle 'Killing is wrong' in order to argue for pacifism, that is, for refusing to go to war. If we are to accept the principle that killing is wrong, then it also follows that capital punishment is wrong and even that killing in self-defence is wrong.

In order to answer this type of question, you first need to understand the argument, so look for the conclusion and for the reasons in the usual way. This should enable you to see what principle the argument relies on in order to draw its conclusion. You then need to consider each possible answer to see which one follows from the principle.

The conclusion of this argument is that smokers who get heart disease as a result of smoking should not get free health treatment. The reason given for this is that their illness is self-inflicted. This reasoning relies on the general principle that if your actions have caused your illness or injury, you should make a financial contribution to your treatment.

The correct answer is option **E**, which applies the principle to motor cyclists whose failure to wear a crash helmet has caused their head injuries.

A is not an application of the principle, because it suggests that even if a child's actions (eating sweets) have caused a health problem (dental decay), the child should nevertheless have free treatment.

B is not an application of the principle, because it makes a recommendation based on people's ability to pay for treatment rather than on whether their actions have caused their illness.

C is not an application of the principle, because, like **B**, it makes its recommendation solely on the ability to pay.

D is not an application of the principle, because it recommends free treatment regardless of whether people's actions have contributed to their injuries.

Problem Solving

Problem Solving involves reasoning using numerical and spatial skills. The Problem Solving questions in this 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 these categories.

The examples on the following pages show the three types of Problem Solving question in this 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 kind of question demands Relevant Selection, in which the task is to select only that information which 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.

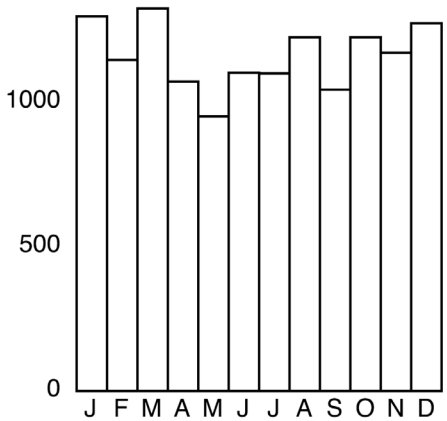
For the third largest party to have as many seats as possible, the other two must have only slightly more seats. If we divide the remaining 359 seats as nearly as possible into thirds, we get: 1st = 120; 2nd = 120; 3rd = 119. However, this violates the condition that no two parties have the same number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

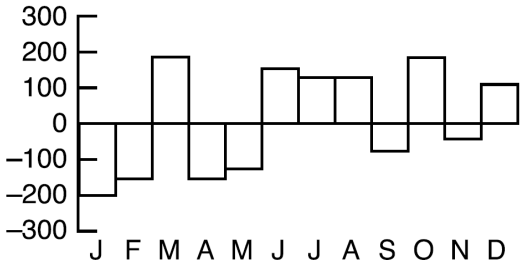
These questions are about being able to recognise data in a different form to that presented. The data is often presented in two different forms such as a table and then some graphs. It may also include spatial reasoning.

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

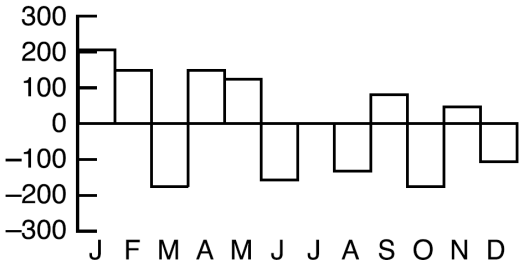


Which one of the following graphs could show the actual change in the bank balance each month?

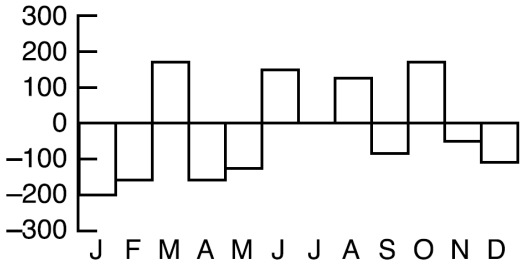
A



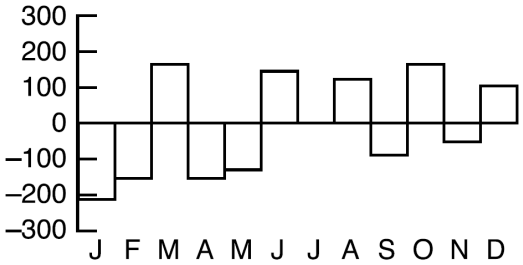
B



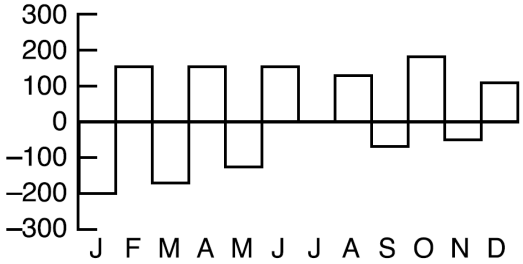
C



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: Mathematics and Biology

The material that follows outlines the mathematical and biological knowledge assessed in Section 1 Part B of the Psychological and Behavioural Sciences Admissions Assessment.

Section 1 Part B consists of 15 Mathematics questions and 15 Biology questions. Topics in Mathematics that are assumed knowledge are labelled 'M', and those in Biology are labelled 'B'.

Throughout Section 1 Part B, 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}

Candidates are expected to be familiar with the use of negative indices in units.

MATHEMATICS

M1. Units

M1.1 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.

M1.2 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.

M2. Number

M2.1 Order positive and negative integers, decimals and fractions.

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

M2.2 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 and negative.

Understand and use place value.

M2.3 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).

M2.4 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.

M2.5 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.)

M2.6 Use and understand the terms: *square*, *positive* and *negative square root*, *cube* and *cube root*.

M2.7 Use index laws to simplify numerical expressions, and for multiplication and division of integer, fractional and negative powers.

M2.8 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.

M2.9 Convert between terminating decimals, percentages and fractions.

Convert between recurring decimals and their corresponding fractions.

M2.10 Use fractions, decimals and percentages interchangeably in calculations.

Understand equivalent fractions.

M2.11 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: $\frac{3}{\sqrt{7}}$, $\frac{5}{3+2\sqrt{5}}$, $\frac{7}{2-\sqrt{3}}$, $\frac{3}{\sqrt{5}-\sqrt{2}}$.

M2.12 Calculate with upper and lower bounds, and use in contextual problems.

M2.13 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.

M2.14 Use approximation to produce estimates of calculations, including expressions involving π or surds.

M3. Ratio and proportion

M3.1 Understand and use scale factors, scale diagrams and maps.

M3.2 Express a quantity as a fraction of another, where the fraction is less than 1 or greater than 1.

M3.3 Understand and use ratio notation.

M3.4 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.

M3.5 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.

M3.6 Understand and use proportion.

Relate ratios to fractions and to linear functions.

M3.7 Identify and work with fractions in ratio problems.

M3.8 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.

M3.9 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 $\frac{1}{y}$.

M3.10 Compare lengths, areas and volumes using ratio notation.

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

M3.11 Set up, solve and interpret the answers in growth and decay problems, including compound interest, and work with general iterative processes.

M4. Algebra

M4.1 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 $a \div b$.

M4.2 Use index laws in algebra for multiplication and division of integer, fractional, and negative powers.

M4.3 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*.

M4.4 Collect like terms, multiply a single term over a bracket, take out common factors, and expand products of two or more binomials.

M4.5 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.

M4.6 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.

M4.7 Rearrange formulae to change the subject.

M4.8 Understand the difference between an equation and an identity.

Argue mathematically to show that algebraic expressions are equivalent.

M4.9 Work with coordinates in all four quadrants.

M4.10 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.

M4.11 Identify and interpret roots, intercepts and turning points of quadratic functions graphically.

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

M4.12 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

M4.13 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.

M4.14 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.

M4.15 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.

M4.16 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.

M4.17 Solve linear inequalities in one or two variables.

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

M4.18 Generate terms of a sequence using term-to-term or position-to-term rules.

M4.19 Deduce expressions to calculate the nth term of linear or quadratic sequences.

M5. Geometry

M5.1 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.

M5.2 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.

M5.3 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.

M5.4 Understand and use the basic congruence criteria for triangles (SSS, SAS, ASA, RHS).

M5.5 Apply angle facts, triangle congruence, similarity, and properties of quadrilaterals to results about angles and sides.

M5.6 Identify, describe and construct congruent and similar shapes, including on coordinate axes, by considering rotation, reflection, translation and enlargement (including fractional and negative scale factors).

Describe the changes and invariance achieved by combinations of rotations, reflections and translations.

Describe translations as 2-dimensional vectors.

M5.7 Know and use the formula for Pythagoras' theorem: $a^2 + b^2 = c^2$

Use Pythagoras' theorem in both 2 and 3 dimensions.

M5.8 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).

M5.9 Apply the standard circle theorems concerning angles, radii, tangents and chords, and use them to prove related results:

a. angle subtended at the centre is twice the angle subtended at the circumference
b. angle in a semicircle is 90°
c. angles in the same segment are equal
d. angle between a tangent and a chord (alternate segment theorem)
e. angle between a radius and a tangent is 90°
f. properties of cyclic quadrilaterals

M5.10 Solve geometrical problems on 2-dimensional coordinate axes.

M5.11 Know the terminology *faces*, *surfaces*, *edges* and *vertices* when applied to cubes, cuboids, prisms, cylinders, pyramids, cones, spheres and hemispheres.

M5.12 Interpret plans and elevations of 3-dimensional shapes.

M5.13 Use and interpret maps and scale drawings.

Understand and use three-figure bearings.

M5.14 Know and apply formulae to calculate:

a. the area of triangles, parallelograms, trapezia
b. the volume of cuboids and other right prisms.

M5.15 Know the formulae:

a. circumference of a circle = $2\pi r = \pi d$
b. area of a circle = πr^2
c. volume of a right circular cylinder = $\pi r^2 h$

Formulae relating to spheres, pyramids and cones will be given if needed.

Use formulae to calculate:

a. perimeters of 2-dimensional shapes, including circles
b. areas of circles and composite shapes
c. surface area and volume of spheres, pyramids, cones and composite solids

M5.16 Calculate arc lengths, angles and areas of sectors of circles.

M5.17 Apply the concepts of congruence and similarity in simple figures, including the relationships between lengths, areas and volumes.

M5.18 Know and use the trigonometric ratios:

$$\sin\theta = \frac{\text{opposite}}{\text{hypotenuse}} \qquad \cos\theta = \frac{\text{adjacent}}{\text{hypotenuse}} \qquad \tan\theta = \frac{\text{opposite}}{\text{adjacent}}$$

Apply these to find angles and lengths in right-angled triangles and, where possible, general triangles in 2- and 3-dimensional figures.

Know the exact values of $\sin\theta$ and $\cos\theta$ for $\theta = 0°, 30°, 45°, 60°, 90°$.

Know the exact values of $\tan\theta$ for $\theta = 0°, 30°, 45°, 60°$.

Candidates are not expected to recall or use the sine or cosine rules.

M5.19 Apply addition and subtraction of vectors, multiplication of vectors by a scalar, and diagrammatic and column representations of vectors.

Use vectors to construct geometric arguments and proofs.

M6. Statistics

M6.1 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.

M6.2 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*.

M6.3 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.

M6.4 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.

M7. Probability

M7.1 Analyse the frequency of outcomes of probability experiments using tables and frequency trees.

M7.2 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.

M7.3 Relate relative expected frequencies to theoretical probability, using appropriate language and the ‘0 to 1’ probability scale.

M7.4 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.

M7.5 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.

M7.6 Construct theoretical possibility spaces for single and combined experiments with equally likely outcomes, and use these to calculate theoretical probabilities.

M7.7 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.

BIOLOGY

B1. Cells

B1.1 Know and understand the structure and function of the main sub-cellular components of both animal and plant eukaryotic cells to include:

a. cell membrane
b. cytoplasm
c. nucleus
d. mitochondrion
e. cell wall (plant only)
f. chloroplast (plant only)
g. vacuole (plant only)

B1.2 Know and understand the structure and function of the main sub-cellular components of prokaryotic cells (bacteria) to include:

a. cell membrane
b. cytoplasm
c. cell wall
d. chromosomal DNA/no 'true' nucleus
e. plasmid DNA

B1.3 Know and understand the levels of organisation as: cells to tissues to organs to organ systems.

B2. Movement across membranes

B2.1 Know and understand the processes of diffusion, osmosis and active transport, including examples in living and non-living systems.

B3. Cell division and sex determination

B3.1 Mitosis and the cell cycle:

a. Know and understand that the cell cycle includes interphase (the cell grows and DNA is copied) and mitosis (division leading to two daughter cells that have the same number of chromosomes so are genetically identical to each other and the parental cell).
b. Know and understand the role of mitosis in growth by increasing cell numbers, repair of tissues, replacement of worn out cells and asexual reproduction.
c. Understand that cancer is the result of changes in cells that lead to uncontrolled growth and division.

B3.2 Meiosis and the cell cycle:

a. Know and understand the cell cycle includes interphase (the cell grows and DNA is copied) and meiosis (division that produces daughter cells, known as gametes, in which the chromosome number is halved from diploid to haploid so they have a single set of chromosomes). Each daughter cell will be genetically different.

b. Know and understand the role of meiosis in reducing the chromosome number and that the full chromosome complement is restored at fertilisation.

B3.3 Asexual and sexual reproduction:

a. Know and understand that asexual reproduction involves one parent and that offspring are genetically identical when no mutations occur.

b. Know and understand that sexual reproduction involves two parents and that offspring are genetically different in relation to each other and the parents, leading to (increased) variation.

B3.4 Sex determination:

a. Know that, in most mammals including humans, females are XX and males are XY.

b. Be able to establish the sex and ratio of offspring using genetic diagrams.

B4. Inheritance

B4.1 Know the nucleus as a site of genetic material/chromosomes/genes in plant and animal cells.

B4.2 Know and understand the following genetic terms:

a. gene
b. allele
c. dominant
d. recessive
e. heterozygous
f. homozygous
g. phenotype
h. genotype
i. chromosome

B4.3 Monohybrid crosses:

a. Use and interpret genetic diagrams to depict monohybrid (single gene) crosses.
b. Use family trees/pedigrees.
c. Express outcome as ratios, numbers, probabilities or percentages.
d. Understand the concept of inherited conditions.
e. Know that most phenotypic features are the result of multiple genes rather than a single gene inheritance.

B5. DNA

B5.1 Understand that:

a. the genome is the entire genetic material (DNA) of an organism.

b. chromosomes contain DNA.

B5.2 Describe the structure of DNA:

a. Know that DNA is a polymer made up of two strands forming a double helix.

b. Know that DNA is made from four different nucleotides, each consisting of a common sugar and phosphate group along with one of four different bases attached to the sugar.

c. Know the complementary pairs of bases – adenine (A) with thymine (T), guanine (G) with cytosine (C) – and that the sequence of these bases is the genetic code.

B5.3 Protein synthesis:

a. Know and understand that genes carry the code for proteins.

b. Know and understand that the genetic code is 'read' as triplets, and that each triplet codes for an amino acid.

c. Understand that protein synthesis involves the production of proteins from amino acids.

B5.4 Gene mutations:

a. Understand that a mutation is a change in the DNA.

b. Know that most mutations have no effect on the phenotype, some will have a small effect, whilst occasionally others will determine the phenotype.

B6. Gene technologies

B6.1 Genetic engineering:

a. Understand the process of genetic engineering to include:

i. taking a copy of a gene from (DNA/chromosomes of) one organism.

ii. insertion of that gene into the DNA of another organism.

iii. the roles of restriction enzymes and ligases.

b. Recall examples of genetic engineering in different cell types.

c. Explain the benefits and risks of using genetic engineering in medical applications.

B6.2 Stem cells:

a. Know that embryonic stem cells can give rise to any cell type.

b. Know that cells lose this ability as an animal matures.

c. Know the functions of stem cells including adult stem cells.

d. Explain the benefits and risks of using stem cells in medical applications.

B6.3 Selective breeding:

a. Understand the impact of selective breeding on domesticated animals.

B7. Variation

B7.1 Natural selection and evolution:

a. Know that there is usually extensive genetic variation within a population of a species.

b. Describe evolution as a change in the inherited characteristics of a population over time through a process of natural selection which may result in the formation of a new species.

c. Explain how evolution can occur through natural selection of variants that give rise to phenotypes best suited to their environment.

d. Understand antibiotic resistance and that it is an example of evolution through natural selection.

B7.2 Sources of variation:

a. Understand that variation can be genetic/inherited, resulting in a range of phenotypes.

b. Understand that variation can also be environmental, which affects a range of phenotypes.

B8. Enzymes

B8.1 Understand that enzymes are biological catalysts.

B8.2 Understand the mechanism of enzyme action including the active site and enzyme specificity.

B8.3 Understand the factors affecting the rate of enzyme action:

a. temperature

b. pH

B8.4 Know the role of the amylases, proteases and lipases in digestion.

B9. Animal physiology

B9.1 Respiration:

a. Understand the process of cellular respiration.

b. Understand the process of aerobic respiration, including the word equation.

c. Understand the process of anaerobic respiration in animals, including the word equation.

B9.2 Organ systems:

a. Nervous system:

i. Understand that the central nervous system comprises the brain and spinal cord.

ii. Explain the structure and function of sensory neurones, relay neurones, motor neurones, synapses and the reflex arc.

b. Respiratory system:

i. Explain the structure and function of the respiratory (breathing) system, including the structure of the thorax.

ii. Understand the processes of ventilation and gas exchange.

iii. Understand the importance of a high surface area : volume ratio for the gas exchange process.

c. Circulatory system:

i. Understand the structure and function of the circulatory system, including the heart, heart rate and ECGs, and the blood vessels (arteries, veins and capillaries).

ii. Understand the composition and function of the blood (red blood cells carry oxygen; white blood cells are involved in antibody production and phagocytosis; platelets are involved in blood clotting; and plasma is involved both in the transport of blood components and other dissolved substances including hormones, antibodies, urea and carbon dioxide, and in the distribution of heat).

iii. Understand the relationship with the gaseous exchange system.

iv. Understand the need for exchange surfaces and a transport system in multicellular organisms in terms of surface area : volume ratio.

d. Digestive system:

i. Understand the structure and function of the digestive system.

ii. Understand the processes of peristalsis, digestion, absorption and egestion.

e. Excretory system:

i. Understand the structure and function of the excretory system, including the kidney and the nephron.

ii. Understand the role of the kidneys in homeostasis.

B9.3 Homeostasis:

a. Know that homeostasis is the maintenance of a constant internal environment, and appreciate its importance.
b. Understand the concept of negative feedback.
c. Understand the regulation of blood glucose levels, including the role of insulin and glucagon.
d. Understand type 1 and type 2 diabetes, and how type 1 diabetes can be treated.
e. Understand the regulation of water content (including ADH) and the regulation of temperature.

B9.4 Hormones:

a. Recall that hormones are released from specific endocrine glands and travel in the blood to their target structures.
b. Explain the roles of thyroxine and adrenaline in the body, including thyroxine as an example of a negative feedback system.
c. Describe the role of hormones in human reproduction including:
    i. those in the menstrual cycle (FSH, LH, oestrogen and progesterone)
    ii. those in contraception, and the differences between hormonal and non-hormonal forms of contraception.

B9.5 Disease and body defence:

a. Communicable diseases:
    i. Know that communicable diseases are caused by pathogenic bacteria, viruses, protists and fungi.
    ii. Understand the transmission routes of sexually transmitted infections, including the effect on the immune system of HIV which results in AIDS.
    iii. Understand the treatment of disease, including the use of antibiotics, vaccines (role of dead and inactive pathogens, antibody production and formation of memory cells) and techniques to prevent the spread of pathogens including HIV.
    iv. Understand the process of discovery and development of new medicines including pre-clinical and clinical testing.
b. Non-communicable diseases:
    i. Know that the following diseases are caused by the interaction of many factors: cardiovascular disease, many forms of cancer, some lung and liver diseases and diseases influenced by nutrition, including type 2 diabetes.
    ii. Know that cardiovascular disease can be treated/managed using life-long medication (including statins, anti-coagulants and anti-hypertensive drugs), surgical procedures (including stents and bypass for coronary heart disease), and lifestyle changes (including reducing smoking, more exercise and a balanced diet).

B10. Ecosystems

B10.1 Levels of organisation in an ecosystem:

a. Describe the organisation of levels within an ecosystem from individuals through to populations, and from communities through to ecosystems.
b. Understand that communities are affected by abiotic and biotic factors.
c. Appreciate the factors that can cause a population to change in size.
d. Describe the importance of interdependence in ecosystems (relating to predation, mutualism and parasitism) and of competition in a community.
e. Know and understand that photosynthetic organisms are the primary producers of food in an ecosystem, and therefore biomass.

B10.2 Material cycling:

a. Explain the importance of the carbon cycle to include the following processes:
    i. photosynthesis
    ii. respiration
    iii. combustion
    iv. decomposition
b. Understand the importance of the water cycle to living organisms.

B10.3 Biodiversity:

a. Understand how quadrats and belt transects are used to investigate the distribution and abundance of organisms in a habitat.
b. Explain how to determine the number of organisms in a given area.
c. Describe the positive and negative human interactions in an ecosystem and explain their impact on biodiversity including fish farming, acid rain and eutrophication.

B11. Plant physiology

B11.1 Importance of photosynthesis:

a. Describe the process of photosynthesis, and describe it as an endothermic reaction that uses light energy to react carbon dioxide and water to produce glucose and oxygen.

b. Describe photosynthetic organisms as the main producers of food and therefore biomass.

c. Explain the effect of temperature, light intensity and carbon dioxide concentration as limiting factors on the rate of photosynthesis.

B11.2 Transport systems in plants:

a. Explain how the structures of xylem and phloem are adapted to their functions in the plant including:

   i. lignified dead cells in xylem tissue, which transports water and mineral ions from the roots to the stems and leaves.

   ii. living cells in phloem tissue, which transports dissolved sugars from the leaves to the rest of the plant for immediate use or storage.

b. Explain how water and mineral ions are taken up by plants, relating the structure of the root hair cells to their function.

c. Describe the processes of transpiration and translocation, including the structure and function of the stomata.

d. Explain the effect of environmental factors on the rate of water uptake by a plant including light intensity, air movement, humidity and temperature.

e. Calculate the rate of transpiration as:

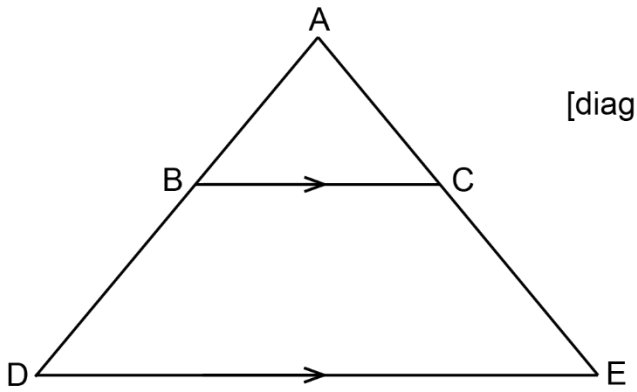
$$\frac{\text{volume of water}}{\text{time taken}}$$

Example questions for Part B (Mathematics and Biology)

In the following questions, the correct answer has been <u>underlined</u>.

Example 1: Mathematics

A shape is formed by drawing a triangle *ABC* inside the triangle *ADE*.



[diagram not to scale]

BC is parallel to *DE*.

$AB = 4$ cm $\quad BC = x$ cm $\quad DE = (x+3)$ cm $\quad DB = (x-4)$ cm

What is the length, in cm, of *DE*?

A 5

B 7

<u>C</u> 9

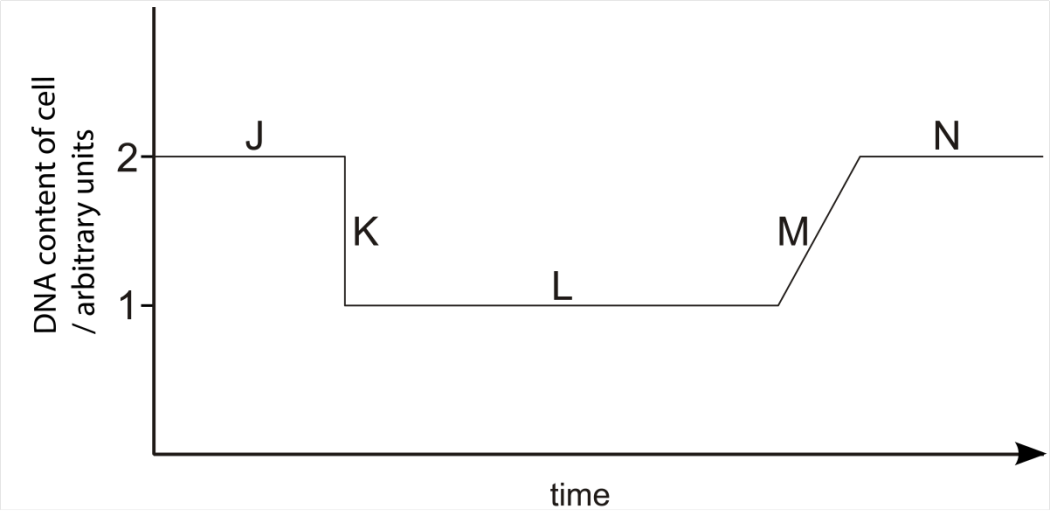
D $4+2\sqrt{7}$

E $7+2\sqrt{7}$

Example 2: Biology

Before a cell can divide by mitosis, DNA synthesis has to take place. Following DNA synthesis, the DNA is separated into each half of the cell and then the cell divides.

The following graph shows the DNA content per cell over a period of time.



Which of the letters on the graph represent the sequence of the three events described above?

	cell divides	*DNA synthesis*	*DNA separates*
A	J	K	L
B	J	L	M
C	K	L	M
D	K	M	N
E	L	M	N
F	L	M	J
G	M	N	J
H	M	N	K

Part C: Reading Comprehension

Section 1 Part C (Reading Comprehension) of the Psychological and Behavioural Sciences Admissions Assessment assesses the ability to understand and draw meaning from texts, with questions in a multiple-choice format. This part of the assessment is not subject-specific, and texts included will be on a variety of topics and may be drawn from a range of sources. Candidates will have 40 minutes to complete this part of the assessment.

All academic subjects require the ability to critically read a variety of sometimes challenging texts for meaning. Specifically, the tasks in Section 1 Part C focus on identifying the ways in which the texts are structured, the main ideas being presented, and the ways in which these are supported and developed.

The reading comprehension consists of three tasks, each based around text excerpts. Each task will have a set of multiple-choice questions with four options. Questions will not require specialist knowledge or any information beyond what is contained within the texts.

Content

Each task will use recently written texts, from authentic sources, in English. Sources may include works of non-fiction (at a relatively high level conceptually and linguistically but which do not assume specialist subject knowledge), newspapers, general interest magazines, book reviews, abstracts written for research papers or journal articles, and professional websites. Texts will not depend on the understanding of specific aspects of British culture.

Questions will require candidates to:

- look at the main ideas and focus of a text.
- analyse the detail, and distinguish opinions and attitudes presented in the text.
- determine the writer's purpose in writing the text, including consideration of intended audience.
- extract implications and implicitly stated elements of the text.
- draw comparisons and contrasts within a text or between different texts.

For all tasks, the emphasis is on identification of opinion, attitude, purpose and inferred meaning rather than the retrieval of directly stated factual details. Questions may also focus on elements of text organisation that support meaning, such as the use of exemplification and comparison.

Format

Section 1 Part C (Reading Comprehension) consists of three tasks. **Candidates will be required to answer all questions in all of the tasks**.

Each task will consist of one or more text excerpts and a set of four-option multiple-choice questions. There will be no overlap between tasks. Answers to questions will not depend on other questions.

Task 1: Understanding short texts

Questions in this task are on two short abstracts or reviews on a common topic. Texts will be no more than 200 words each. The task assesses candidates' ability to identify, compare and contrast features of two different texts. The candidate's understanding of the two texts is tested through discrete questions aiming to cover a wide range of focuses with the emphasis on identification of opinion, attitude, purpose and inferred meaning rather than the retrieval of directly stated factual details. Questions may also focus on elements of text organisation which support meaning, such as the use of exemplification, comparison and reference.

Task 2: Multiple-matching

Questions in this task are on four short extracts, either from four different writers on the same theme or four extracts from the same source. Extracts will be no more than 200 words each. This task requires candidates to locate where in a text a particular idea is expressed, discounting ideas in other texts which may appear similar but do not reflect the whole of the question accurately. Each question requires the candidate to scan the four texts to locate the area of text which appears to contain the answer, and then to read this carefully to check that it is the correct answer.

Task 3: Understanding extended text

Questions in this task are on one extended text (of no more than 1000 words). The task assesses the understanding of a longer stretch of academic text that may include argument, supported claims, and reference to previous work and ideas in a particular field.

Scoring

All questions are worth 1 mark. Marks are not deducted for incorrect answers, so candidates are advised to answer all questions.

Example questions for Part C (Reading Comprehension)

Example Task 1:

Read the two abstracts below, which give summaries of two academic articles relating to cities and urban development. For questions 1-6, choose the option (**A**, **B**, **C** or **D**) which you think fits best according to the texts.

ABSTRACT ONE

Retrofitting cities: Local governance in Sydney, Australia
Robyn Dowling, Pauline McGuirk, Harriet Bulkeley
Transforming cities to a lower carbon future is a key challenge of contemporary urban governance. Retrofitting the city – or modifying existing urban infrastructures, buildings and daily life to suit different energy sources and expectations of energy consumption – is essential to this transformation. In urban studies, little focus has been applied to the shape and character of urban governance frameworks and mechanisms required to successfully retrofit cities. In this paper we address this lacuna by exploring the logics, practices and dynamics of retrofitting governance in the Australian city. Using a governmentality perspective, the paper identifies the involvements of different scales of government in retrofitting policies and mechanisms and connections between them. Based on our survey of carbon reduction initiatives involving government, business and community actors across Australia's cities, we outline the types of retrofitting solutions being proposed and enacted. Focussing on initiatives from Sydney, Australia's largest city, the paper documents four key techniques through which retrofitting is being governed – self-governing, holistic, facilitative and educative. The findings indicate that governance gaps remain in attending to the daily life of technologies and the materiality of daily life.

ABSTRACT TWO

Critical research on eco-cities? A walk through the Sino-Singapore Tianjin Eco-City, China
Federico Caprotti
This article uses the narrative tool of a walk through Tianjin Eco-City, China, as an entry point in raising and discussing key questions in contemporary eco-city research. Eco-city projects are becoming increasingly prevalent in policy and political-economic discourses in a variety of locations as new urban spaces where blueprints for low carbon economies can be trialled. In light of this, the article highlights the necessity of, firstly, considering scale when analyzing eco-city 'futures'. Secondly, the article argues for the need to interrogate eco-cities' definitions, as well as their evaluation, performance and monitoring frameworks, as this will aid in critical analyses of the marketing and presentation of actually built eco-city projects. Thirdly, the question of internal social resilience needs to be assessed: this is of crucial importance in light of the exclusive, gated nature of several flagship eco-city projects under construction at present. Lastly, the article argues that research on eco-city projects needs to consider not only high-tech, new urban environments, but also the low-paid workers who form what the article calls the 'new urban poor', forming large, often transient populations on the edges of flagship 'sustainable' urban projects worldwide.

1 According to Abstract One, what is the main aim of the article on retrofitting cities?

A to defend the idea of retrofitting

B to point out weaknesses in retrofitting technology

C to describe the technology required for retrofitting

D to look at methods of achieving retrofitting

2 Which word from Abstract One describes the theoretical framework used by the writers in their analysis of retrofitting in Sydney?

A 'lacuna'

B 'governmentality'

C 'holistic'

D 'materiality'

3 In Abstract One, the writers claim that one feature of their research is that

A they have engaged with an area representing a weakness in the field.

B they have proposed a way of integrating key techniques.

C they have identified potentially divisive underlying attitudes.

D they have employed a controversial methodology.

4 In Abstract Two, the writer says that eco-city projects are important because

A they show that low-carbon economies are sustainable.

B they provide an opportunity for testing economic models.

C they offer new opportunities for disadvantaged groups.

D they encourage political involvement in environmental issues.

5 In Abstract Two, ‘exclusive, gated nature’ contrasts with

A ‘internal social resilience’.

B ‘new urban environments’.

C ‘new urban poor’.

D ‘projects under construction’.

6 Which abstract or abstracts refer to the physical experience of a particular city being used as a stylistic device?

A neither abstract

B both abstracts

C Abstract One only

D Abstract Two only

Answer Key:

1 D **2** B **3** A **4** B **5** C **6** D

APPENDIX 2: SKILLS ASSESSED IN SECTION 2

Section 2 of the Psychological and Behavioural Sciences Admissions Assessment requires students to write a short essay, discussing a quotation on a topic of general interest. It requires no specialist or background knowledge.

Section 2 is designed to assess candidates' ability to:

- think analytically and produce a coherent argument, using relevant evidence.
- write with clarity and precision under time pressure.

Example questions:

Choose **one** of the quotations below and use **the space provided in this question paper** to discuss it.

---

1. *The fact is, you have fallen lately, Cecily, into a bad habit of thinking for yourself. You should give it up. It is not quite womanly... men don't like it.*

Oscar Wilde, *Lady Windermere's Fan* (1893)

2. *Biology gives you a brain. Life turns it into a mind.*

Jeffrey Eugenides, *Middlesex* (2002)

3. *There are some ideas so wrong that only a very intelligent person could believe in them.*

George Orwell (attributed)

4. *Memory itself is an internal rumour.*

George Santayana, *The Life of Reason* (1905)

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