BioMedical Admissions Test (BMAT)

Section 2: Mathematics

Knowledge Checklist

M1 - Units

Subtopics	Key points to understand	✓
Standard Units	● Units for mass ○ Miligram (mg) ○ Gram (g) ○ Kilogram (kg) ○ Tonne (t) ● Units for force ○ Newtons (N) ● Units for length ○ Milimetre (mm) ○ Centimetre (cm) ○ Metre (m) ○ Kilometre (km) ● Units for area ○ Square millimetre (mm^2) ○ Square centimetre (cm^2) ○ Square metres (m^2) ○ Square kilometres (km^2) ● Units for capacity ○ Mililitre (ml) ○ Litre (l) ● Units for volume ○ Cubic millimetres (mm^3) ○ Cubic centimetres (cm^3) ○ Cubic metres (m^2) ○ Mililitres (ml) ○ Litres (l) ● Units for time ○ Seconds ○ Minutes ○ Hours ○ Days ○ Weeks ○ Months ○ Years	
Compound Units	● When two quantitative measurements are combined together, a compound unit is used (e.g. kilometers per hour = kmh^{-1}). ● How to use compound units for speed, rates of pay, density, unit pricing and pressure.	
Changing Between Standard Units	● How to change between standard units in algebraic and numeric sums: ○ For example, 1m = 100cm = 1000mm	

Changing Between Compound Units	● How to change each unit present in the compound unit separately, using conversion factors, in algebraic and numeric sums.	

M2 - Numbers

Subtopics	**Key points to understand**	✓
Types of Numbers	● How to use the terms: ○ Square ○ Positive ○ Negative square root ○ Cube ○ Cube root	
The Four Operations	● How to apply the four operations of addition, subtraction, multiplication and division to the positive or negative of the following: ○ Integers ○ Decimals ○ Simple fractions (proper/mixed) ○ Mixed numbers ● The meaning of and be able to use place value. ● How to use the cancellation process to simplify calculations or expressions. ● How to use method of priority for operations including: ○ Brackets ○ Powers ○ Roots ○ Reciprocals	
Multiples, Factors, Prime Factors	● The meaning of and be able to identify: ○ Multiples/common multiples ○ Factors/common factors ○ Prime numbers/prime factors ○ LCM (Lowest Common Multiple) ○ HCF (Highest Common Factor) ● How to use the factorisation theorem.	
Systematic Listing Strategies	● How to use systematic listing strategies. ○ For example, if there are *m* ways of doing one thing and *n* ways of doing another thing, the total number of ways that both things can be done in order is *m* x *n*).	

Index Laws	● How to convert numbers to index form. ● How to evaluate numbers in index form. ● How to use the index laws in simplification, multiplication and division. ● Index laws:. ○ Multiplication: ■ aman =am+n ■ (ab)n=anbn ○ Division: ■ am an = am-n ○ Fractions (the power will apply to both the numerator and denominator): ■ (ab)m = ambm ○ Negative powers: ■ a-m = 1am ○ Raise powers to another power: ■ (am)n =am n=(an)m ○ Fractional powers: ■ amn=(na)m=nam	
Standard Form	● A number in standard form: a 10n ○ Where 1a<10 ○ n is how far the decimal point moves, n is positive for numbers greater than 1 and negative for numbers smaller than 1. ● Manipulate numbers in standard form using: ○ Addition ○ Subtraction ○ Multiplication ○ Division ● To order numbers in standard form, first look at n and then a.	
Decimals, Percentages and Fractions	● Recall common conversions between (terminating) fractions, decimals and percentages. ● Convert between any given fraction, decimal and percentage. ● How to use fractions, decimals and percentages interchangeably in calculations.	
Fractions	● How to use equivalent fractions. ● Convert between mixed numbers and improper fractions. ● Compare fractions (by finding a common denominator). ● How to cancel fractions to their lowest terms.	

Decimals	● Convert between: ○ Terminating decimals and fractions ○ Recurring decimals and fractions	
Fractions, Surds and Multiples	● When you calculate with fractions the answer is normally kept as a fraction, unless the question asks for a decimal or percentage. ● How to calculate to get an exact answer with fractions, surds and multiples of π. ● Use approximation to find estimate answers to calculations with expressions involving surds. ● Calculations with surds: ○ Simplifying surds by splitting and then simplifying: ■ E.g. $12 = 4 3 = 4 3 = 2 3$ ○ Multiplication of surds: ■ $x \ y = xy$ ○ Division of surds: ■ $x \ y = xy$ ○ Rationalising denominators. ○ Surds cannot be simply added and subtracted.	
Upper and Lower Bounds	● Identify lower and upper bounds. ● Calculate maximum and minimum values (using lower and upper bounds).	
Rounding Numbers	● Identify and write numbers to a given number of decimal places (d.p.). ● Identify and write numbers to a given number of significant figures (s.f.). ● Estimate values. ● How to use inequality notation to specify simple error intervals relating to truncation and rounding.	

M3 - Ratio and Proportion

Subtopics	Key points to understand	✓
Ratio	● Express ratios: ○ In their simplest form. ○ In the form of 1:n in a multiplicative relationship. ● To compare ratios, they must have the same units. ● Manipulation of ratios with: ○ Multiplication ○ Division ● How to compare lengths, area and volume using ratio notation. ● How to make links (trigonometry ratios) and scale factors.	
Percentages	● Calculate a percent of any given value. ● Define percentage as a number of parts per hundred. ● Find the result given a percentage increase/decrease. ● Express a given value as a percentage. ● Find the percentage change between two given values. ● Find the original value, given the new value and the percentage change. ● Calculate simple interest using the formula: Interest = x0RT100 where x0=initial value, R=interest rate, T=time	
Compound growth and decay	● Understand the concept of compound growth and decay: ○ The base value (principal) used to calculate interest/growth/decay changes after every time period to reflect additional value (interest/growth/decay) gained within that particular period. ● Recall the formula: Final Value = x0(1 +r100)t where x0=initial value, *r* = % change per unit time, *t* = time ● Use the formula to calculate: ○ Compound Interest ○ Depreciation (decrease in value) ○ Compound growth ○ Compound decay ● How to work with iterative processes: ○ This is when the same rule or set of rules are used multiple times e.g. compound interest.	

M4 - Algebra

Subtopics	Key points to understand	✓
Sequences	● Express a sequence as a formula with n ○ Example: 7n-4 ● Find the n^{th} term of a sequence. ● Determine if a value lies within a given sequence. ● Be able to calculate the nth term for linear and quadratic sequences from expressions.	
Powers and Roots	● The basic rules of powers: ○ x1=x ○ x0=1 ○ 1x=1 ○ (ab)x=axbx ○ a-x=1ax ○ axy=yax ● Manipulation of powers in: ○ Multiplication ○ Division ● Find the roots of a squared number ○ Example: x2=y x = y	
Algebra Basics	● The basic rules that govern algebra. ● Manipulation of algebraic expressions: ○ Simplification ○ Expansion ○ Factorisation ● Recall common formulas: ○ a2-b2=(a+b)(a-b) ○ (a+b)2=a2+2ab+b2 ○ (a-b)2=a2-2ab+b2	
Surds	● The meaning of surds. ● Manipulation of surds in: ○ Multiplication ○ Division ○ Addition or subtraction ● Be able to simplify surds.	
Solving Linear Equations	● How to construct and solve linear equations to calculate unknown values.	

Quadratics	● Know the quadratic equation x=-bb2-4ac2a ● Identify and interpret roots, intercepts and turning points of quadratic functions on a graph. ● Find approximate solutions to quadratic equations using graphs. ● How to complete the square in order to find out the root and turning points. ● Be able to factorise quadratic equations, including the difference of two squares. ○ x2+bx+c ● How to construct and solve quadratic equations to calculate unknown values.	
Algebraic Fractions	● How to simplify algebraic fractions. ● How to manipulate algebraic fractions when: ○ Adding ○ Subtracting ○ Multiplying ○ Dividing	
Inequalities	● The symbols used in inequalities: ○ > ○ ○ < ○ . ● How to show inequalities on a number line, graph or in words. ● How to solve algebraic inequalities. ○ Example: Find the integer values of x for which x-37 and 4x-5>22	
Graphical Inequalities	● How to show inequalities on a graph.	
Simultaneous Equations	● How to use algebra to solve simultaneous equations. ● How to use graphs to solve simultaneous equations, to find approximate solutions.	
Direct and Inverse Proportion	● How to write a proportionality statement as an equation: ○ Direct proportion (y=kx) ○ Inverse proportion (y=kx) where k is an unknown, and y and x are variables.	
Rational Expressions	● How to add and subtract rational expressions ● How to multiply and divide rational expressions. ● How to work out rational expressions involving sums or differences. ● How to work out rational expressions with quadratics.	

Linear Functions	● Pairs of parallel lines and perpendicular lines and the relationship between their gradients. ● How to find the equation of a line through two points or through one point with a given gradient. ● How to identify and interpret gradients and intercepts of linear functions graphically and algebraically: ○ y=mx+c	
Graphs	● Interpret results in graphs for: ○ Distance-time ○ Speed-time ○ Financial contexts ● How to calculate and estimate: ○ Gradients of graphs ○ Area under the graph ● How to interpret graphs in real contexts, to find approximate solutions to kinematic problems, such as: ○ Distance ○ Speed ○ Acceleration ● How to recognise, sketch and interpret graphs of: ○ Linear functions ○ Quadratic functions ○ Simple cubic functions ○ Reciprocal functions ■ y=1xwith x0 ○ Exponential functions ■ y=kxfor positive values of k ○ Trigonometric functions for angles of any size ■ y=sinx, y=cosx, y=tanx	

M5 - Geometry

Subtopics	Key points to understand	✓
Geometry	● Fundamental rules of geometry: ○ Angles in a triangle add up to 180° ○ Angles on a straight line add up to 180° ○ Angles in a quadrilateral add up to 360° ○ Angles around a point add up to 360° ○ Exterior angle of a triangle = sum of opposite interior angles of a triangle ○ Isosceles triangles have 2 sides of equal length and 2 base angles of equal degree ● The basic rules of parallel lines: ○ Alternate angles are equal ○ Allied angles add up to 180° ○ Corresponding angles are equal ● The basic rules of parallelograms: ○ Neighbouring angles add up to 180° ○ Opposite angles are equal	
Quadrilaterals and Triangles	● Understand the congruence criteria for triangles ○ SS, SAS, ASA, RHS ● How to define the properties of each different type of triangle: ○ Scalene ○ Isosceles ○ Equilateral ● The properties and definition of special types of quadrilaterals: ○ Square ○ Rectangle ○ Parallelogram ○ Trapezium ○ Kite ○ Rhombus	

Definitions	● The definitions for: ○ Points ○ Lines ○ Line segments ○ Vertices ○ Edges ○ Planes ○ Parallel lines ○ Perpendicular lines ○ Right angles ○ Subtended angles ○ Polygons ○ Regular polygons ○ Polygons with reflection and/or rotational symmetry ○ Faces, surfaces, edges, vertices (for cubes, cuboids, prisms, cylinders, pyramids, cones, spheres and hemispheres.	
Geometry Problems	● Be able to solve geometry problems using the rules of geometry outlined above.	
Polygons	● How to find an exterior angle: ○ Exterior angle =360°n ○ Sum of exterior angles = 360° ● Know how to find an interior angle: ○ Interior angle= 180°-exterior angle ○ Sum of interior angles =(n-2)180° where n is the number of sides.	
Symmetry and Tessellations	● The difference between the 2 types of symmetry: ○ Line symmetry ○ Rotational symmetry ● How to use the interior angle to work out if a regular polygon tessellates.	
Circle Geometry	● Calculate arc lengths angles and areas of sectors of circles. ● The fundamental rules: ○ A tangent to a circle is perpendicular to the radius. ○ 2 radii can be joined to form an isosceles triangle. ○ The perpendicular bisector of a chord passes through the centre of a circle. ○ The angle subtended by the diameter of a circle at the circumference of the circle = 90° ○ Angles in the same segment are equal ○ Angle subtended at the centre is twice the angle subtended at the circumference. ○ Angle in a semicircle is 90°.	

Transformations	Be able to describe: ● A translation using a 2 dimensional vector. ● A rotation using the angle of rotation, direction of rotation and centre of rotation. ● A reflection by giving the equation of the mirror line. ● An enlargement using the scale factor and the centre of enlargement. ● A combination of transformations as a single transformation. ● The ratio of the areas of two similar figures is equal to the square of the ratio of any two corresponding lengths of the figures. ○ If A1and A2denote the areas of two similar figures, and l1and l2denote their corresponding lengthsA1A2=(l1l2)2 ● The ratio of the volumes of two similar figures is equal to the cube of the ratio of any two corresponding lengths of the figures. ○ If V1and V2denote the areas of two similar figures, and l1and l2denote their corresponding lengthsV1V2=(l1l2)3	
Different Shapes	● How to prove two triangles are congruent. ● How to find similar shapes. ● Describe changes and invariance by different rotations, reflections and translations. ● How to interpret plans and elevations of 3 dimensional shapes.	
Projections	● How to draw a front elevation. ● How to draw a side elevation. ● How to draw a plan.	

Area	● Understand and be able to recall the formulas: ○ Area of triangle =12base vertical height ○ Area of quadrilateral =base vertical height ○ Area of trapezium =12sum of both sides vertical height ○ Area of circle =πr2 ○ Circumference of circle =2πr ○ Area of sector =angle of sector 360area of full circle ○ Length of arc=angle of sector 360circumference of fullcircle ● How to find the area of composite shapes. ● The difference between a minor sector and major sector of a circle. ● Use formulae to calculate: ○ Perimeters of two dimensional shapes. ○ Surface area and volume of spheres, pyramids, cones and composite solids.	
Surface Area	● Be able to recognise nets of common shapes. ● Understand and be able to recall the formulas: ○ Surface area of sphere =4πr2 ○ Surface area of cone=πrl+πr2 ○ Surface area of cylinder=2πrh+2πr2	
Volume	● Understand and be able to recall the formulas: ○ Volume of cuboid=lengthwidthheight ○ Volume of prism=cross-sectional arealength ○ Volume of sphere =43πr3 ○ Volume of pyramid=13base areaheight ○ Volume of cone=13πr2h ○ Volume of frustum =volume of cone - volume of removed cone	
Density and Speed	● Know that density=massvolume ● Know that speed=distancetime ● Be able to interpret distance-time graphs.	
Bearings	● How to find and plot a bearing. ● Be able to draw and interpret scale drawings.	

M6 - Pythagoras and Trigonometry

<table>
<tr><th>Subtopics</th><th>Key points to understand</th><th>✓</th></tr>
<tr><td>Pythagoras Theorem</td><td>● How to use in 2 and 3 dimensions.
● a2+b2=c2for right-angled triangles</td><td></td></tr>
<tr><td>Trigonometry: Sine, Cosine, Tangent</td><td>● sin(x)=oppositehypotenuse
● cos(x)=adjacent hypotenuse
● tan(x)=oppositeadjacent
● tan(x)=sin(x)cos(x)
● How to use trigonometry to find the angle of depression/ angle of elevation.
● Common values for trigonometry to be learned:
<table>
<tr><td>x (°)</td><td>sin (x)</td><td>cos (x)</td><td>tan (x)</td></tr>
<tr><td>0</td><td>0</td><td>1</td><td>0</td></tr>
<tr><td>30</td><td>12</td><td>32</td><td>33</td></tr>
<tr><td>45</td><td>22</td><td>22</td><td>1</td></tr>
<tr><td>60</td><td>32</td><td>12</td><td>3</td></tr>
<tr><td>90</td><td>1</td><td>0</td><td>undefined</td></tr>
</table></td><td></td></tr>
<tr><td>3D Pythagoras</td><td>● a2+b2+c2=d2for cuboids and pyramids with a square base.</td><td></td></tr>
<tr><td>3D Trigonometry</td><td>● How to use trigonometry to find the angle between a line and a plane.</td><td></td></tr>
<tr><td>Vectors</td><td>● Vectors have both a magnitude and a direction.
● Different vector notations:
○
○ a
○ a
○
○
● A scalar has magnitude but no direction.
● How to multiply a vector with a scalar.
● Manipulation of vectors for:
○ Addition
○ Subtraction
○ Multiplication
○ Division</td><td></td></tr>
</table>

M7 and M8 - Statistics and Probability

Subtopics	Key points to understand	✓
Sampling and Bias	● A representative sample needs to be: ○ Random ○ Large enough to represent the population. ● How to spot sample bias.	
Collecting Data	● Organisation of quantitative and qualitative data into classes. ● Design a questionnaire: ○ Clear and easy to understand ○ Easy to answer ○ Fair - not leading or biased ○ Easy to analyse	
Summary Values	● How to use like to like summary values to compare data sets. ● The advantages and disadvantages of summary values.	
Mean, Median, Mode and Range	● The meaning of and be able to find the: ○ Mean ○ Median ○ Mode/modal class ○ Range ● Know that only estimates can be obtained for grouped data. ● How to choose the best average for a given scenario.	
Averages and Spread	● How to find the interquartile range for graphical grouped data. ● Comparison of data using: ○ Averages (mean/median/mode) ○ Spread (range/interquartile range)	
Frequency Tables	● How to use a frequency table to find the: ○ Mean ○ Median ○ Mode ○ Range ● How to do the following from a grouped frequency table: ○ Estimate the mean ○ Find the modal class ○ Find the class containing the median	
Basic Graphs	● How to interpret bar charts. ● How to plot a bar chart from a grouped frequency table. ● How to interpret line graphs.	

Cumulative Frequency	● How to draw a cumulative frequency graph from a data set. ● How to estimate the following from a cumulative frequency graph: ○ Median ○ Interquartile range	
Histograms and Frequency Density	● How to interpret and construct histograms with equal and unequal class intervals. ● frequency density =frequencyclass width ● frequency=area of bar	
Other Graphs and Charts	● How to analyse the frequency of outcomes of probability experiments from tables and frequency trees. ● Given a data set, understand how to draw and interpret: ○ A frequency polygon ○ A two-way table ○ Pictograms for categorical data	
Pie Charts	● Be able to: ○ Interpret a pie chart ○ Draw a pie chart	
Scatter Graphs	● Finding the strength of correlation between two variables from a scatter graph. ● How to interpret scatter graphs. ● Recognise correlation and know it does not mean causation is present. ● Draw estimated best fit lines. ● Interpolate and extrapolate trends ○ Be aware of the problems of doing so	
Comparing Data Sets	● Be able to use a combination of graphs and tables to compare data sets.	
Probability	● Probabilities lie between 0 and 1. ● The sum of all probabilities is 1. ● Calculate combined probability using AND/OR Rules. ● How to interpret and calculate conditional probability using expected frequencies through two-way tables, tree diagrams and venn diagrams. ● How to calculate theoretical probability by constructing theoretical spaces for single and combined experiments with outcomes that are equally likely. ● Relate relative expected frequencies to theoretical probability.	
Listing Outcomes and Expected Frequency	● Use a sample space diagram to list all possible outcomes. ● expected frequency =probabilitynumber of trials	

Tree Diagrams	● How to draw a tree diagram. ● Be able to use a tree diagram to calculate probability. ● The use of tree diagrams to represent: ○ Probabilities that are independent of the previous outcome. ○ Probabilities that are dependent on the previous outcome.	
Relative Frequency	● relative frequency=frequencynumber of trials ● Using relative frequency to estimate probability.	
Venn Diagrams	● Understand set notation ○ { }- set of elements ○ ∈ - element of ○ ∉ - not an element of ○ ∪ - union ○ ∩ - intersection ● List elements in a set. ● Meaning of a set complement. ● Present the following on venn diagrams: ○ Sets ○ Unions ○ Intersections ● Use venn diagrams to find probabilities.	
Experiments	● How to apply ideas of randomness, fairness and equally likely events to calculate expected outcomes of future multiple experiments. ● Outcome can be different every time an experiment is repeated.	