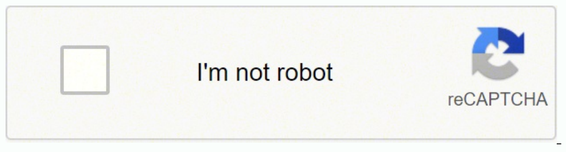

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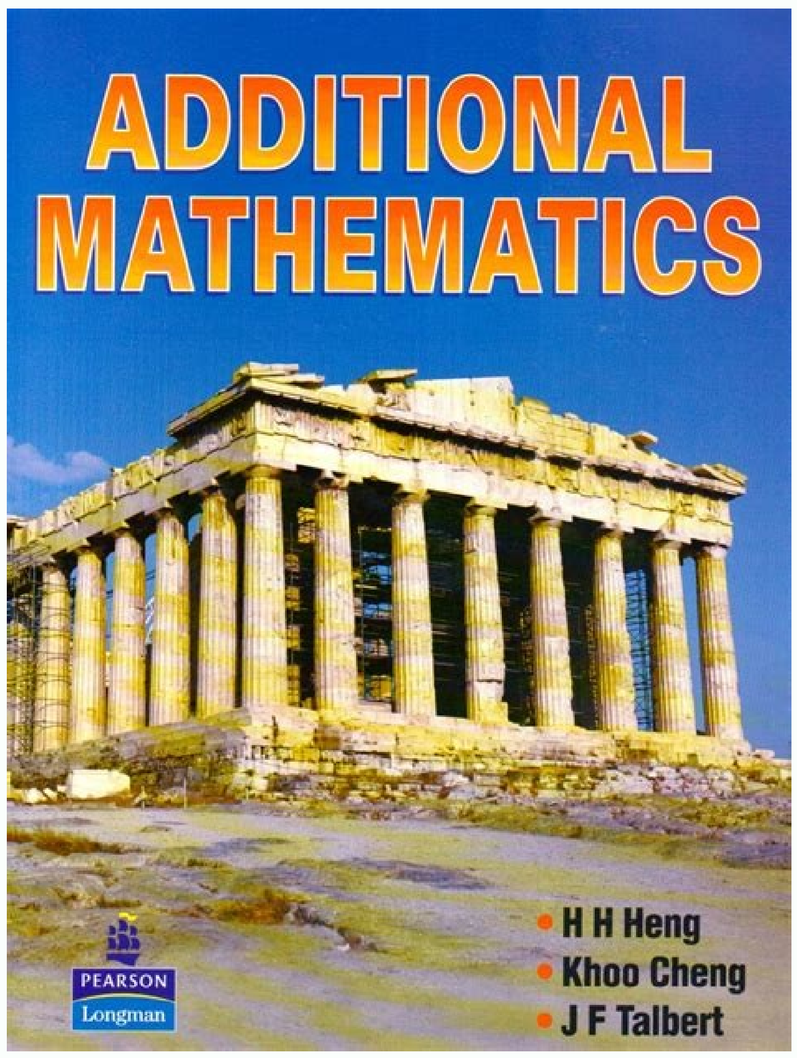

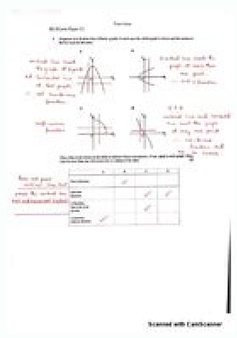

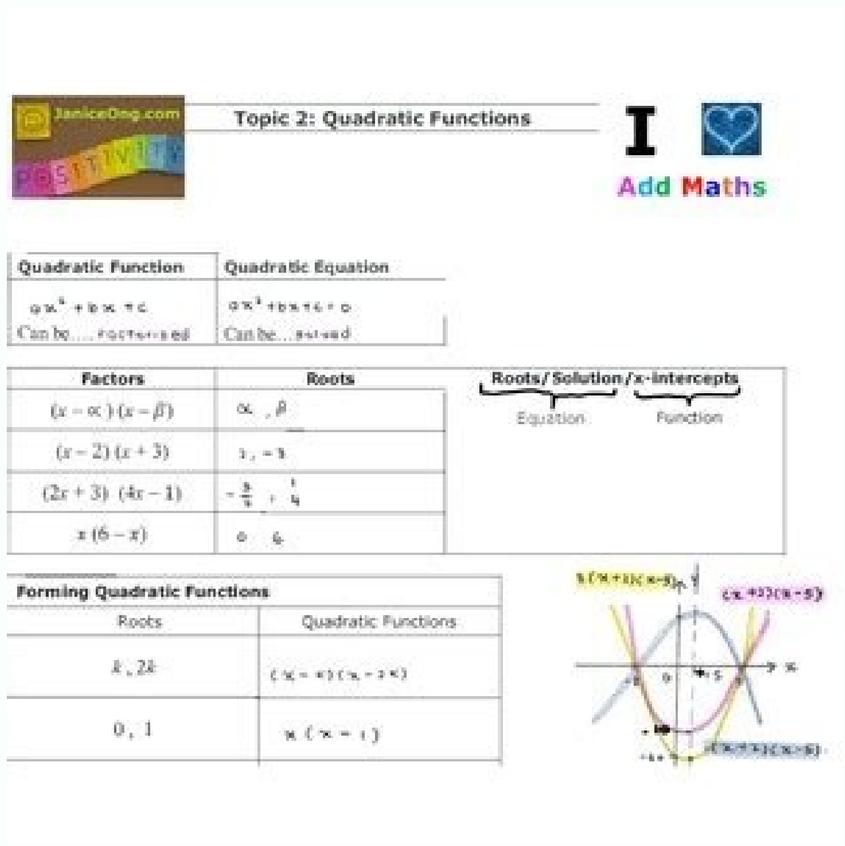

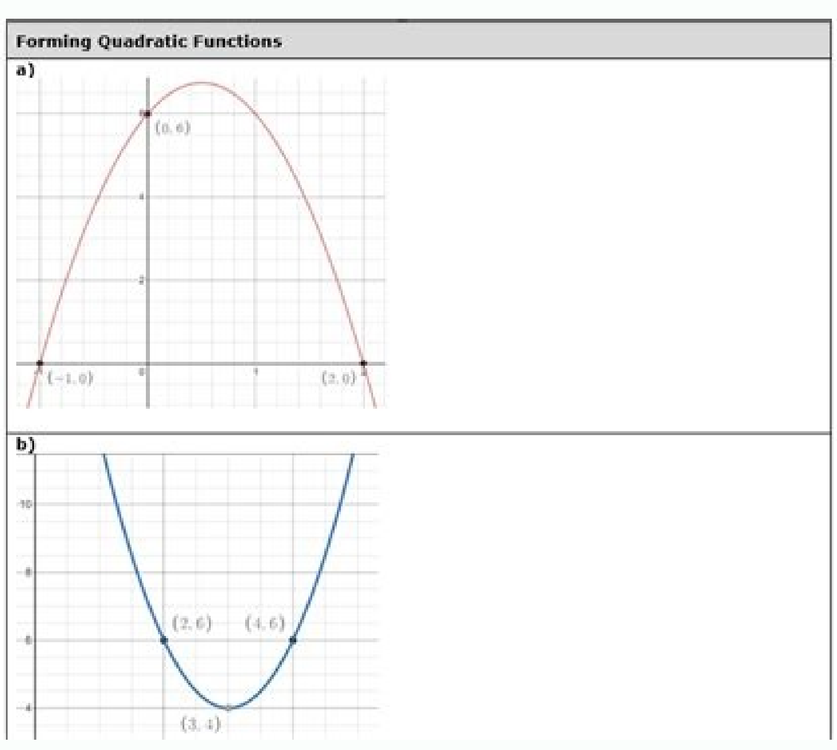

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Approach 1 y 3x c Line goes through (3, 7) so y 7 when x 3 7 3(3) c c 2 y 3x 2 Approach 2 (preferred) Gradient is y7 3 x (3) y 7 3(x 3) y 7 3x 9 y 3x 2 34 First Edition © C Morris. A polynomial of degree 3 is cubic. We can work through this is stages In order to get the 2x 3 term a is clearly 2. Solution Let f (x) 2 x 3 5 x 2 x 6 f (1) 2 5 1 6 2 0 so (x 1) is not a factor f (1) 2 5 1 6 0 so (x 1) is a factor You can then go through two different routes. The value of r 2 must be positive Examples x 2 y2 121 is a circle centre the origin and radius 11. OCR Additional Mathematics FSMQ (6993) Revision Notes Version 1.1 March 2008 Clive Morris (E&OE) 1 First Edition © C Morris. Example 2 Use the factor theorem to factorise the cubic polynomial 2 x 3 9 x 2 7 x 6 Solution Let f (x) 2 x 3 9 x 2 7 x 6 f (1) 2 9 7 6 6 0 so (x 1) is not a factor of f (x) f (1) 2 9 7 6 12 0 so (x 1) is not a factor of f (x) f (2) 16 36 14 6 0 so (x 2) is a factor of f (x) 2 x 3 9 x 2 7 x 6 (x 2)(2 x 2 bx 3) In the quadratic bracket on the right the x 2 coefficient must be 2 to give 2x 3 when you multiply out. Solution The gradient of y 2 x 7 is 2 so the equation of the required line is given by y 3 2 x (3) y 3 2(x 3) y 3 2x 6 y 2x 9 Example Find the equation of the line that is perpendicular 3x 2 y 2 0 and goes through the point (2, 5) giving your answer in the form ax by c 0 where a, b and c are integers. The remainder theorem Be able to find the remainder of a polynomial up to order 3 when divided by a linear factor. Example 2 Solve the equation 16 12 x 2 x 2 0 by completing the square. Pursuing this route gives Let f (x) 2 x3 5 x 2 x 6 f (2) 16 20 2 6 0 so (x 2) is a factor 2 x 3 5 x2 x 6 (x 1)(x 2)(2 x 3) This final factor comes from observing that it must start with a 2x to give 2x 3 and must end up with 3 to get 6 . Solution P(at least one six) 1 P(no sixes) 1 56 0.99 n 56 n 1 0.99 56 n 0.01 56 25 0.01048... Length of a Line Segment y (x2 , y 2) Distance between (x1 , y1) and (x2 , y2) (x2 x1)2 (y2 y1) 2 x (x1 , y1) Example Find the length of the line segment joining the points (3, 7) and (2, 8) . In this case it does and leads to 2 x 3 9 x 2 7 x 6 (x 2)(x 3)(2 x 1) 14 First Edition © C Morris. Index Index..... Be able to integrate kxn where n is a positive integer or 0, and the sum of such functions. 5 sin tan cos First Edition © C Morris. A polynomial of degree 0 is a constant. This is called the remainder theorem. Finding the Equation of a Normal to a Circle The equation of a normal to a circle can be tackled in a similar fashion to the equation of the tangent. 3x 2 3 y 2 147 is a circle centre the origin and radius 7 since it can be rewritten as x 2 y 2 49 by dividing throughout by 3. Be able to use differentiation and integration with respect to time to solve simple problems involving variable acceleration. (2 x 3 2 x2 x 3) (x 2)(2 x2 bx c) d The next stage is to look at the coefficient of x 2 . Algebra Rationalising Surds As well as the surds at IGCSE Level you may be asked to simplify more complicated surds using the difference of two squares as an aid. Be able to use graphs of linear inequalities to solve 2-dimensional maximisation and minimisation problems, know the definition of objective function and be able to find it in 2-dimensional cases. Reminder Remember that lines parallel to the x-axis are of the form y k where k is a constant and lines parallel to the y-axis are of the form x k where k is a constant. Solving Cubic Equations Using The Factor Theorem Example 1 Show that x 1 is a factor of x 3 1 and hence factorise x 3 1 . Addition and subtraction of polynomials When adding or subtracting polynomials combine the terms with the same powers. In the Additional Mathematics examination you are not given a formula sheet and so the only formulae you will have with you are the ones that you have taken in there in your head! You are advised to make your own list of things to learn from the work covered during the Additional Mathematics course. Examples (3 2 x 2 x 2 3x 3) (7 5 x 3x 2 x 3) 3 7 2 x 5 x 2 x 2 3x 2 3 x 3 x 3 10 3x 5 x 2 4 x 3 (6 2 x 4 x 3) (4 4 x 7 x 2) 6 4 2 x (4 x) 7 x 2 4 x3 2 6 x 7 x 2 4 x3 8 First Edition © C Morris. Which lines are parallel to L and which lines are perpendicular to L. So we have that for positive integer values of n only. Example 1 Complete the square on y 2 x 2 8 x 2 and hence find the coordinates of the maximum point on the curve. Remember that the equation of a normal to a circle at a particular point, P say, has the same gradient as the gradient of the line joining P to the centre of the circle. Be aware that integration is the reverse of differentiation. then one of the factors will start (2 x...) or (3x...) but it is better to leave this to naturally appear as example 2 shows rather than looking for it directly. Co-ordinate Geometry The Straight Line Gradient of a Straight Line y (x2 , y 2) x Gradient y 2 y1 x2 x1 (x1 , y1) Example Find the gradient of the line joining the points (3, 7) and (2, 13) . Solving Simultaneous Linear and Quadratic Equations (A Reminder) Example 1 Find where the circle x 2 y 2 25 and the line x y 7 meet. Solution x 4 5 x 2 36 0 (x 2)2 5(x 2) 36 0 y 2 5 y 36 0 (y 9)(y 4) 0 y 9 0 or y 4 0 y 9 or 4 x 2 9 or 4 x 3 since it is not possible for x 2 to be equal to 4 Example 2 4 Solve the equation 2 x 7 0 x Solution 4 2x 7 0 x 2 x 2 7 x 4 0 (multiplying through by x) (2 x 1)(x 4) 0 2 x 1 0 or x 4 0 x 12 or 4 15 First Edition ©

C Morris. Solution of Equations Solving Equations Reducing to Quadratics Example 1 By first making the substitution y x 2 solve the equation x 4 5 x 2 36 0 . The factor theorem Be able to find linear factors of a polynomial up to order 3. A polynomial of degree 1 is linear A polynomial of degree 2 is quadratic. Solution x 2 4 x 3 (x a) 2 b x 2 4 x 3 (x a)(x a) b x 2 4 x 3 x 2 2ax a 2 b Then compare the bits on the 2 sides. y y = (x – 2)(2x + 3)(x – 3) 15 10 5 -5 -4 -3 -2 -1 1 2 3 4 5 6 x -5 -10 f (x) 0 when the curve is on or above the x axis so f (x) 0 when 32 x 2 or x 3. (v) When rearranged this gives x 2 y 2 10 x 2 y 50 0 (x 5)2 (y 1) 2 50 52 12 24 This is not a circle because the right hand can't be a radius squared since it is negative. Be able to solve linear and quadratic inequalities algebraically and graphically. You are usually expected to shade the regions that are excluded e.g. when representing the inequality x 3 you would shade the region that is NOT x 3 y 5 4 3 2 1 y x>3 1 2 3 4 5 x -5 -4 -3 -2 -1-1 -2 -3 -4 -5 x2 5 4 3 2 1 y 5 4 3 2 1 y 5 4 3 2 1 y> –2 1 2 3 4 5 x -5 -4 -3 -2 -1-1 -2 -3 -4 -5 1 2 3 4 5 x -5 -4 -3 -2 -1-1 -2 -3 -4 -5 y y1 y 5 4 3 2 1 -5 -4 -3 -2 -1-1 -2 -3 -4 -5 1 2 3 4 5 x -5 -4 -3 -2 -1-1 -2 -3 -4 -5 4 3 2 1 1 2 3 4 5 x y These together must give x . This is a collection of IGCSE Additional Mathematics notes. Example In the scenario outlined above, the equation of the normal at the point with coordinates (6, 8) on the circle with equation x 2 y2 6 x 8 y 0 is given by y (8) 4 x 6 3 3(y 8) 4(x 6) 4x 3 y 0 Finding the Closest Distance of a Given Point from a Circle Essentially this reduces to finding the coordinates of the point, P, where a line through the given point, A and the centre of the circle, C, meet the circle and use this point to calculate the required distance. Example 1 Write x 2 4 x 3 in the form (x a)2 b . Solution 3x 2 y 2 0 can be rearranged to give y 32 x 1 and therefore has gradient The gradient of the line perpendicular to 3x 2 y 2 0 is therefore given by 1 3 2 23 The equation of the perpendicular line is therefore y (5) 2 x2 3 3(y 5) 2(x 2) 3 y 15 2 x 4 2 x 3 y 11 0 36 3 2 . Regions Solid lines are used for inequalities that include = and dashed lines otherwise. 2 2 3 3 5 3 5 2 2 2 3 4 2 3 3 2 2 3 2 2 42 3 42 3 42 3 43 1 3 5 3 5 9 6 5 5 14 6 5 14 6 9 5 4 3 5 3 5 3 5 2 2 5 7 3 5 7 3 5 2 2 2 Manipulation of Algebraic Expressions A polynomial is an expression that only contains positive integer powers of x and constants. 24 First Edition © C Morris. Binomial Expansions Type 2 (a x) n a n n C1 a n 1 x n C2 a n 2 x 2 nC3 a n 3 x3 n Cr a n r xr x n Example 1 Find the first five terms in the expansion of (1 x)10 in ascending powers of x. 25 First Edition © C Morris. y 10 8 6 4 2 -6 -5 -4 -3 -2 -1-2 -4 -6 -8 (– 2, – 7) -10 2 y = x + 4x – 3 1 2 3 4 5 x Finding the maximum and minimum point for a Quadratic Curve If you have completed the square on a quadratic it is easy to decide where the maximum (or minimum) point on the curve is. Example Find the equation of the line that is parallel to y 2 x 7 and goes through the point (3, 3) . Example 1 x 2 4 x 3 (x 2)2 22 3 (x 2)2 7 Example 2 2 x 2 16 x 7 2(x 2 8x) 7 2(x 4)2 16 7 2(x 4)2 25 Example 3 3 6 x 2 x 2 3 2(x 2 3x) 3 2 (x 32) 2 32 2 152 2(x 32) 2 20 First Edition © C Morris. Be able to solve a cubic equation by factorisation. You are also reminded to learn the formulae from the IGCSE formula sheet including b 2 c 2 a2 any rearrangements of formulae on it e.g. cos A 2bc 7 First Edition © C Morris. c 4 1 c 5 (2 x 3 2 x2 x 3) (x 2)(2 x2 2 x 5) d Equating the constant terms on both sides gives 2 5 d 3 10 d 3 d 7 So (2 x 3 2 x2 x 3) (x 2) (2x2 2 x 5) remainder 7 11 First Edition © C Morris. The minimum point will therefore have coordinates (2, 6) . Know the relationship between the gradients of parallel and perpendicular lines. Finding the Centre and Radius of a Circle The recommended approach to determine whether a given equation is a circle and to determine its centre and radius is simply to complete the square from first principles on the x and y terms. Another way of approaching things is to be found at the end of this section. Solution Let f (x) x3 3 x 2 10 x 24 f (3) 33 3 32 10 3 24 27 27 30 24 0 x 3 is a factor of f (x) x 2 x (2) f (2) (2)3 3 (2)2 10 (2) 24 8 12 20 24 0 x 2 is a factor of f (x) When looking for factors in a polynomial Check to seek whether x or powers of x are factors Start by looking for smaller values of a – a good strategy is check 1, then 1 , then 2, then 2 etc. a 2 (comparing the x 2 terms) 2ab 6 (comparing the x terms) 2 2 b 8 b2 ab 2 c 11 (comparing the numbers) 2 22 c 11 8 c 11 c3 So 2 x 2 8 x 11 2(x 2)2 3 19 First Edition © C Morris. Be able to evaluate definite integrals. Be able to express real situations in terms of linear inequalities. Multiplication of polynomials This is exactly like expanding linear brackets at GCSE. The remainder when f (x) is divided by (x a) is f (a) The remainder when f (x) is divided by (bx a) is f ab Example 1 The remainder when f (x) x 3 2 x 2 7 x 8 is divided by (x 3) is given by f (3) 33 2 32 7 3 8 27 18 21 8 32 . 27 First Edition © C Morris. Solving Quadratic Equations by Completing the Square Example 1 Solve the equation x 2 4 x 3 0 by first completing the square. 4 First Edition © C Morris. Binomial Expansions Type 1 (1 x) n 1 nC1 x n C2 x 2 n C3 x 3 nCr x r xn Where nCr n! . Either take out x 1 as a factor (as in the example on the next page) or find another factor. Completing the Square There are quicker methods for those good with mental gymnastics but this basic routine is always effective. Value of Information given 0 Two distinct solutions 0 One (repeated) solution 0 Solutions 0 No solutions a perfect square The quadratic factorises Examples 3x 2 2 x 4 0 has two solutions because 22 434 52 0 . Example 3 The remainder when f (x) 8 x3 4 x 2 2 x 1 is divided by (2 x 1) is given by f (12) 8 12 4 12 2 12 1 . The angle in a semicircle is a right angle. Example 2 Factorise fully 2 x 3 5x 2 x 6 . y 4 2 C P A 2 4 x 43 Find the centre of the circle Find the distance AC. 6 First Edition © C Morris. Factor Theorem This is a special case of the remainder theorem. Therefore the vertex of the curve (in this case the lowest point) is at (2, 7) . Be able to solve two linear simultaneous equations in 2 unknowns. Be able to find the area between a curve, two ordinates and the x-axis. 8 Rationalising Surds ..... 8 Manipulation of Algebraic Expressions ..... 8 Addition and subtraction of polynomials ..... 8 Multiplication of polynomials..... 9 Division of polynomials ..... 9 Remainder Theorem..... 12 Factor Theorem ..... 13 Solution of Equations..... 15 Solving Equations Reducing to Quadratics..... 15 Solving Simultaneous Linear and Quadratic Equations (A Reminder)..... 16 Completing the Square ..... 17 Another (shorter) way of Completing the Square..... 20 Sketching Quadratics using Completing the Square ..... 21 Finding the maximum and minimum point for a Quadratic Curve ..... 21 Solving Quadratic Equations by Completing the Square..... 23 Solving Cubic Equations Using The Factor Theorem..... 24 Solving cubic and cubic inequalities ..... 26 Discriminant..... 27 The Binomial Expansion ..... 28 Pascal's Triangle ..... 28 Application to Probability – Binomial Distribution..... 30 Co-ordinate Geometry..... Method 3 (2 x 3 2 x2 x 3) (x 2)(ax 2 bx c) d where d is a constant. P(X r) n Cr p r q n r P(X r) n Cr p r (1 p)n r Mean of X np Conditions for use of a Binomial Distribution A binomial distribution can be used to model a situation if Each trial has two possible outcomes (usually referred to as success or failure) There is a fixed number of trials The probability of success in each trial is constant The outcome of each trial is independent of the outcomes of all the other trials In the formula P(X r) n Cr p r (1 p)n r there must be r successes giving rise to the p r part of the formula n r failures giving rise to the (1 p)n r part of the formula The r success can occur in any of n Cr ways. Another method (related to Method 2) is to do the following. Multiply each term in the second bracket by each term in the first bracket and then simplify. Only authorised for use by students at Reading School. Know that (x – a) 2 + (y – b)2 = r2 is the equation of a circle with centre (a, b) and radius r. (iv) When rearranged this gives x 2 4 x y 2 6 y 12 (x 2)2 (y 3)2 12 22 32 25 This is a circle centre (2, 3) and radius 5. The numbers a1, a2 ,... For rectifications reach out to the subject lead. 16 First Edition © C Morris. Trigonometry Ratios of any angles and their graphs Be able to apply trigonometry to triangles with any angles. 33 First Edition © C Morris. are called the coefficients of x, x 2 etc. Example 2 Find the terms in the expansion of (1 2 x)7 in ascending powers of x up to and including the term in x 3 . x2 y2 6 x 8 y 0 (x 3)2 (y 4)2 (3) 2 42 25 Centre is (3, 4), Radius is 5 Gradient of radius to (6, 8) 4 (8) 4 3 6 3 Gradient of tangent at (6, 8) 1 3 4 4 3 The equation of the tangent is therefore as before y (8) 3 x 6 4 4(y 8) 3(x 6) 3x 4 y 50 42 First Edition © C Morris. Example 3 Find the binomial expansion of (3 2 x)5 and use your expansion to estimate 3.0025 correct to 1 decimal place. Distance (2 (3))2 (8 7) 2 52 (15)2 250 25 10 5 10 Finding the Equation of a Straight Line The equation of a straight line is of the form y mx c where m is the gradient and c is the y-intercept. Solving cubic and cubic inequalities Example Solve the equation 2 x 3 7 x 2 3x 18 0 . Co-ordinate Geometry The straight line The co-ordinate geometry of circles Know the definition of the gradient of a line. (3 4 x 2 x 3)(1 x x 2 x3) 3 3x 3x2 3x3 4 x 4 x 2 4 x 3 4 x 4 2 x 3 2 x 4 2 x5 2 x6 3 x 7 x 2 5 x 3 6 x4 2 x5 2 x6 Division of polynomials There are 2 principal methods of dividing one polynomial by another. 50 IGCSE Revisited ..... 50 Applications..... 50 Graphs of Sine, Cosine and Tangent for Any Angle ..... 51 Trigonometric Identities ..... 54 Solving simple trigonometric equations..... 55 Trigonometry and Pythagoras in 3 Dimensions..... 59 Angle between a line and a plane ..... 59 Line of greatest slope..... 59 Angle between two planes..... 60 Calculus..... 0.01 (using trial and improvement) At least 26 dice must be rolled for there to be a probability of at least one six 31 First Edition © C Morris. 26 First Edition © C Morris. Example Find the equation of the line perpendicular to x 4 and going through the point (2, 3) . 4 x 2 4 x 1 0 has one (repeated) solution because 42 4 41 0 . 2a 4 (comparing the x terms) a2 a 2 b 3 (comparing the numbers) 2 2 b 3 4 b 3 b 3 4 7 So x 2 4 x 3 (x 2) 2 7 17 First Edition © C Morris. Be able to use differentiation to find stationary points on a curve. 2 x 2 bx 2 9 x 2 b 4 9 b 5 2 x 3 9 x 2 7 x 6 (x 2)(2 x2 5x 3) As a check look at the x term which should be the same on both sides. Gradient 13 7 20 4 2 (3) 5 Mid-point of a Line Segment x x2 y1 y2 Mid point M is 1 , 2 2 y (x2 , y 2) M x (x1 , y1) Example Find the midpoint of the line joining the points (3, 7) and (2, 13) . Example 2 The remainder when f (x) 3 x3 2 x 2 6 x 8 is divided by (x 2) is given by f (2) 3 (2)3 2 (2)2 6 (2) 8 24 8 12 8 52 . If the coefficient of the highest power of x in the polynomial is a 2 or a 3 etc. The distance between the centre (2, 7) is (8,19) is given by (8 2)2 (19 7) 2 62 122 180 36 5 6 5 The distance from (8,19) to the circle is therefore given by 6 5 55 5 When do circles meet? Trigonometry ..... Example 1 x2 y 2 8 x 6 y 5 0 x2 y 2 8 x 6 y 5 0 (x 4)2 42 (y 3)2 (3)2 5 0 (x 4)2 (y 3)2 20 0 (x 4) 2 (y 3)2 20 This is a circle centre (4, 3) and radius 20 4 5 2 5 . 0.01 56 26 0.008735... Be able to solve simple trigonometrical equations in given intervals. Be able to use the definitions of sin , cos and tan for any angle (measured in degrees only). Solution The circle has centre (2, 7) and radius 5. (iii) When this is expanded you get x 2 2 xy y 2 x 2 2 xy y 2 50 x 2 y 2 25 This is a circle centre the origin and radius 5. 35 First Edition © C Morris. If r1 and r2 are the radii of two circles, r1 r2 and d is the distance between their centres then (i) Circles touch externally (ii) Circles touch internally d r1 r2 (iii) Circles do not intersect d r2 r1 (iii) Circles intersect at two distinct points d r1 r2 r2 r1 d r1 r2 44 First Edition © C Morris. A polynomial is therefore of the form a0 a1 x a2 x 2 a3 x3 an x n . Be able to identify the binomial parameter, p, the probability of success. Note that the x and y values must be paired in the final answer otherwise you may lose marks. Be able to solve two simultaneous equations in 2 unknowns where one equation is linear and the other is quadratic. Example 2 Complete the square on y 3 8x 4 x 2 and hence find the coordinates of the maximum point on the curve. 4 Formulae..... The degree of a polynomial is the highest power of x that occurs. Inequalities Be able to manipulate inequalities. Example x into 2x 3 goes 2x 2 times Find (2 x 3 2 x2 x 3) (x 2) x into 2x 3 goes 2x 2 times Method 1 (Long Division) x2 2x 2 2 x 5 2 x3 2 x 2 x 3 2 x3 4 x 2 x2 2x 2 times (x 2) is (2 x3 4 x2) Take (2 x3 4 x2) from (2 x3 2 x2) and bring down the x 2 x2 4 x 5x 3 2x times (x 2) is (2 x 2 4 x) 5 x 10 7 That is to say Take (2 x 2 4 x) from (2 x 2 x) and bring down the 3 (x 2) does not go into 7 so this is your remainder (2 x 3 2 x2 x 3) (x 2) (2x2 2 x 5) remainder 7 Other ways of writing this are 2 x3 2 x 2 x 3 7 2x 2 2 x 5 x2 x2 or 2 x 3 2 x 2 x 3 (x 2)(2x2 2 x 5) 7 9 First Edition © C Morris. Solution (1 x)10 1 10C1 x 10C2 x 2 10C3 x3 10C4 x 4 ... 6 x 2 x 2 factorises because (1)2 462 49 which is a perfect square. Application to Probability – Binomial Distribution If X is the number of successes in n independent trials each of which has probability p of success and probability q (1 p) of failure then X is said to have a Binomial Distribution with parameters n and p and we write X B(n, p) . 3 2 8 18 4 14 1 1 1 1 1 1 2 12 First Edition © C Morris. Example 2 By solving the equations simultaneously find where the line y 5 x 6 and the curve y x 2 x 2 meet and comment on your answer. (ii) This is not a circle because there is a term in xy . Sketching Quadratics using Completing the Square For example the curve y x 2 4 x 3 i.e. y (x 2)2 7 is the curve y x 2 translated 2 units in the negative x direction and translated 7 units in the negative ydirection. Example 1 The gradient of the line 3x 4 y 7 0 is 3 since rearranging the equation gives 4 3x 4 y 7 0 4 y 3 x 7 3 7 y x 4 4 Example 2 Find an equation of the straight line with gradient 3 going through the point with coordinates (3, 7) . Be able to apply trigonometry to right angled triangles. Be able to solve quadratic equations by factorisation, the use of the formula and by completing the square. NB See also the inequalities section of the IGCSE Revision Notes. Remember that the equation must be in this form before you can read off the gradient. Find AP AC radius . 38 First Edition © C Morris. The binomial expansion Understand and be able to apply the binomial expansion of (a + b)n where n is a positive integer. The Binomial Expansion Pascal's Triangle The coefficients for expanding (1 x)n come from the rows of Pascal's Triangle. Solution (1 2 x)7 1 7C1 (2 x) 7C2 (2 x)2 7 C3 (2 x)3 1 14 x 84 x 2 280 x 3 ... Laying your work out systematically can avoid silly slips being made as shown in the example below. Note that the powers of p and 1 p always add up to n. Material already covered in the IGCSE Revision Notes will not be repeated here. Be able to find a constant of integration. Be able to solve a linear equation in one unknown. Another (shorter) way of Completing the Square Since (x a)2 (x a)(x a) x2 2ax a 2 we can use the fact that x 2 2ax (x a) 2 a 2 In the brackets with the x is half the number of x's in the original expression. Be able to find the equation of a tangent and normal at any point on a curve. 2 Syllabus for OCR FSMQ in Additional Mathematics (6993) ..... Be able to recognise the special case where the use of constant acceleration formulae is appropriate. Solution Where the graphs meet x 2 (7 x)2 25 (subtituting for y in terms of x from x y 7) x 2 49 14 x x 2 25 (expanding) 2 x 2 14 x 24 0 x 2 7 x 12 0 (divide through by 2 to make life easier) (x 3)(x 4) 0 x 3 or 4 y 4 or 3 So the line meets the circle at (3, 4) and (4, 3) . m1 Example The equations of 5 lines are given below. Sometimes a question will ask you to give your answer a specific way e.g. in the form ax by c 0 where a, b and c are integers. 2 25 x 126 x 2 308 x3 ... Set Language and Notation Functions Chapter from textbook – Functions Quadratic Functions Chapter from textbook – The Quadratic Function Indices and Surds Polynomials Chapter from textbook – Remainder Theorem Simultaneous Equations Chapter from textbook – Simultaneous Equations Logarithmic and Exponential Functions Chapter from textbook – Exponential and Logarithmic Functions Chapter from textbook – e and lnx Coordinate Geometry and Linear Law Chapter from textbook – Coordinate Geometry Chapter from textbook – Conversion to Linear Form Circular (Radian) Measure Chapter from textbook – Radians, Arcs and Sectors Trigonometry Chapter from textbook – Trigonometry Permutations and Combinations Binomial Theorem Chapter from textbook – Binomial Expansion Vectors and Relative Velocity Chapter from textbook – Vectors Chapter from textbook – Relative Velocity Matrices Differentiation Chapter from textbook – Differentiation Chapter from textbook – Applications of Differentiation Integration Chapter from textbook – Integration Mathematics - Additional - 0606 - Ebooks Mathematics - Additional - 0606 - Other-resources Mathematics - Additional - 0606 - Syllabus if any paper is still missing, please report using the Contact Us! tab. Calculus Differentiation Be able to differentiate kxn where n is a positive integer or 0, and the sum of such functions. The Coordinate Geometry of Circles Equation of a Circle The equation of a circle centre the origin and with radius r is given by x2 y 2 r 2 The equation of a circle centre (a, b) and with radius r is given by (x a) 2 (y b) 2 r 2 Notes For a circle the x and y coefficients must be the same. 37 First Edition © C Morris. There can never be an xy term in the equation of a circle. Know that the equation of a circle, centre (0,0), radius r is x2 + y2 = r2. 3 2 7 (13) 1 The midpoint is , 2 , 3 2 2 32 First Edition © C Morris. For example the entries in the row beginning 1, 6, 15, 20, 15, 6, 1 come from 6 C0 , 6C1 , 6C2 , 6C3 , 6C4 , 6C5 , 6C6 respectively. Example 2 Write 7 6x x 2 in the form a (x b)2 . Example 3 Find an equation of the straight line through the points with coordinates (2, 5) and (3,15) . Formulae You have been spoilt by not having to learn many mathematical formulae. Solution The line must be of the form y k and since it goes through a point with y-coordinate 3 it must be y 3 . Example Find the point on the circle with equation (x 2)2 (y 7)2 5 that is closest to the point with coordinates (8,19) . Application to probability Recognise probability situations which give rise to the binomial distribution. Know the sine and cosine rules and be able to apply them. The perpendicular from the centre to a chord bisects the chord. Be able to calculate the distance between two points. 40 First Edition © C Morris. If it is not you must rearrange the equation first. Be able to find the area between two curves. Solution Let f (x) 2 x3 7 x 2 3 x 18 f (1) 10 so (x 1) is not a factor of f (x) f (1) 12 so (x 1) is not a factor of f (x) f (2) 0 so (x 2) is a factor of f (x) Either by long division or by comparing coefficients f (x) (x 2)(2 x 2 3x 9) f (x) (x 2)(2 x 3)(x 3) f (x) 0 when x 2 or 3 or 32 Consider the graph of y f (x) 2 x 3 7 x 2 3x 18. Two lines with gradients m1 and m2 are perpendicular if and only if m2 NB If in an exam you are asked to show that two lines are perpendicular, show that when you multiply their gradients you get 1 . Useful Properties in Circle Problems The diameter is twice the length of the radius. Expanding on the right hand side gives (2 x 3 2 x 2 x 3) ax3 bx 2 cx 2ax 2 2bx 2c d (2 x 3 2 x 2 x 3) ax3 bx 2 2ax2 cx 2bx 2c d So equating coefficients a 2 b 2a 2 (comparing coefficients of x 3) (comparing coefficients of x 2) b 4 2 b2 c 2b 1 (comparing coefficients of x) c 4 1 c5 2c d 3 (comparing constants) 10 d 3 d 7 (2 x 3 2 x 2 x 3) (x 2) (2x2 2 x 5) remainder 7 10 First Edition © C Morris. L : y 2x 5 M : 4x 2 y 8 N: P: 2y x 4 2x 4 y 5 R: 4x 2 y 3 0 Rearranging the lines give L : y 2x 5 M : y 2x 4 N: y 12 x 2 P: y 12 x 25 R: y 2 x 32 This shows that M and R are parallel to L and N are perpendicular to L. 3x 2 2 x 3 0 has no solutions because 22 433 32 0 . Remainder Theorem There is a much easier way of finding the remainder when you divide by a linear term. The terms that will have an x 2 in come from x bx and 2 2x 2 . Be able to solve problems using these formulae. If the quadratic factorises we can now complete the factorisation. Solution (2 3 x)(1 2 x)7 (2 3x)(1 14 x 84 x 2 280 x3 ...) 2 28 x 168 x 2 560 x3 3 x 42 x 2 252 x3 ... Solution (3 2 x)5 35 5C1 34 (2 x) 5C2 33 (2 x)2 5C3 32 (2 x)3 5C4 31 (2 x)4 (2 x)5 243 810 x 1080 x 2 720 x 3 240 x4 32 x5 3.0025 (3 2 0.001)5 243 810 0.001 (since higher power terms will not affect first dp) 243.8 (1 decimal place) 29 First Edition © C Morris. Solution 2 x 2 8 x 11 a(x b)2 c 2 x 2 8 x 11 a(x b)(x b) c 2 x 2 8 x 11 ax 2 2bx b2 c 2 x 2 8 x 11 ax 2 2abx ab2 c Then compare the bits on the 2 sides. To find the value of b look at the x 2 term on the right hand side when you multiply out and compare this with the x 2 term on the left hand side. Know that the gradient function Know that the gradient of the function is the gradient of the tangent at that point. The tangent to a circle at a point is perpendicular to the radius at that point. On the right hand side this is 2 5 x 3x 7 x which agrees with the left hand side. .....62 Equations of tangents and normals ..... 63 Location and Nature of Stationary Points ..... 64 Sketching Curves ..... 67 Practical Maximum and Minimum Problems ..... 68 Integration..... 69 Integration as the Reverse of Differentiation ..... 69 Indefinite Integration of powers of n, constant multiples, sums and differences ....69 Finding the constant of integration using given conditions ..... 70 Definite Integrals..... 71 Area between a curve and the x axis ..... 71 Area between two curves..... 74 Application to Kinematics ..... 75 Motion in a Straight Line ..... 75 SUVAT Equations (Constant Acceleration Formulae) ..... 79 Displacement-time and Velocity-time Graphs..... 83 These Revision Notes contain the material that is additional to the IGCSE syllabus. Be able to form the equation of a straight line. Integration Be able to determine the nature of a stationary point. This was last updated May/June 2019. Be able to calculate probabilities using the binomial distribution. If you needed answers to 3 decimal places they would be 4.646 and 0.646. Using the last form from above: (2 x 3 2 x2 x 3) (x 2)(ax 2 bx c) d where d is a constant. Syllabus for OCR FSMQ in Additional Mathematics (6993) Those statements in bold are in the Additional Mathematics syllabus but are not on the IGCSE syllabus. First Edition © C Morris. The maximum point will therefore have coordinates (1, 7) . Example 3 Write 2 x 2 8 x 11 in the form a(x b)2 c . Hence solve the inequality 2 x 3 7 x 2 3x 18 0 . If you are given 2 points you can obviously find the gradient from this. Application to kinematics dy gives the gradient dx of the curve and measures the rate of change of y with respect to x. Be able to find the mid-point of a line segment. 39 First Edition © C Morris. Solution y 2 x2 4 x 2 y 2(x 2)2 2 2 (2)2 y 2(x 2)2 6 Since the smallest value of 2(x 2) 2 6 will be when x 2 the minimum value of y 2 x 2 8 x 2 will be y 6 when x 2 . 21 First Edition © C Morris. 2b 6 (comparing the x terms) b 3 a b2 7 (comparing the numbers) a (3)2 7 a 9 7 a 16 So 7 6 x x 2 16 (x 3)2 18 First Edition © C Morris. First Edition © C Morris. Be able to draw a straight line given its equation. Know what is meant by an indefinite and a definite integral. Be able to apply trigonometry to 2 and 3 dimensional problems. y (5) 15 (5) x2 3 2 Gradient y 5 20 4 x 2 5 y 5 4(x 2) y 5 4 x 8 y 4 x 3 Parallel and Perpendicular Gradients Two lines are parallel if and only if they have the same gradient. Example 2 Which of the following are equations of circles and why (i) x 2 2 y2 6 x 8 y 36 (ii) x 2 y 2 2 xy 6 x 12 y 11 0 (iii) (x y)2 (x y)2 50 (iv) y 2 x2 4 x 6 y 12 (v) x 2 y 2 10 x 2 y 50 0 Solutions (i) This is not a circle because the coefficients of x 2 and y 2 are not the same. Be able to solve simultaneous equations graphically. Method 2 (Comparison of Coefficients) From Method 1 it is clear that when you divide a cubic by a linear term you will obtain a quadratic plus a constant remainder. 32 The Straight Line..... 32 Gradient of a Straight Line..... 32 Mid-point of a Line Segment ..... 32 Length of a Line Segment ..... 33 Finding the Equation of a Straight Line ..... 33 Parallel and Perpendicular Gradients..... 35 The Coordinate Geometry of Circles..... 38 Equation of a Circle ..... 38 Finding the Centre and Radius of a Circle ..... 39 Useful Properties in Circle Problems ..... 41 Finding the Equation of a Tangent to a Circle ..... 42 Finding the Equation of a Normal to a Circle ..... 43 Finding the Closest Distance of a Given Point from a Circle ..... 43 When do circles meet?..... 44 Regions ..... 45 Applications to Linear Programming ..... 47 2 First Edition © C Morris. 3 First Edition © C Morris. Be careful that you give the answer in the required form. r !(n r)! n Note that nCr is sometimes written as (NB no fraction line!) r 28 First Edition © C Morris. Example 1 It is known that in a certain population 15% are left handed, Find the probability that in a sample of 9 people (a) exactly 5 are left handed (b) at most 3 are left handed Find also(d) the mean number of people who are left handed Solution X B (9, 0.15) (a) P(X 5) 9C5 0.155 0.854 0.00499 (3 sf) (b) P(X 3) P(X 0 or 1 or 2 or 3) P(X 3) 0.859 9C1 0.151 0.858 9C2 0.152 0.857 9C3 0.153 0.856 0.966 (3 sf) (c) P(X 1) 1 P(X 0) P(X 1) 1 0.859 0.768 (3 sf) (d) Mean 9 0.15 1.35 Example 2 How many fair cubical dice must be rolled for there to be a 99% chance of obtaining at least one six? Solution of equations Be confident in the use of brackets. 1 10 x 45x 2 120 x 3 210 x 4 ... Inequalities Be able to illustrate linear inequalities in two variables. 22 First Edition © C Morris. 30 First Edition © C Morris. Know and be able to use the identity that Know and be able to use the identity sin 2 cos 2 1 . The discriminant gives quite a lot of information about the solutions of a quadratic equation and whether the quadratic factorises. Solution Where the graphs meet x 2 x 2 5 x 6 (equating y values) x2 4 x 4 0 (x 2)2 0 x2 y 5 2 6 4 So since there is one repeated solution y 5 x 6 is a tangent to y x 2 x 2 when x 2 and y 4 i.e. at the point (2, 4) . These together must give 2x 2 . All lines perpendicular to a line of the form y k1 will therefore be of the form x k 2 where k1 and k2 are constants and vice versa. So b2 4ac . 13 First Edition © C Morris. Solution Let f (x) x 3 1 f (1) 13 1 0 x 1 is a factor of x 3 1 x 3 1 (x 1)(ax 2 bx c) ax 3 (b a) x 2 (c b) x c Comparing coefficients we have a 1 b a b 1 0 b 1 c b c 1 0 c 1 x 3 1 (x 1)(x2 x 1) This cannot be factorised further as x 2 x 1 does not factorise. Solution y 4 x 2 2 x 3 y 4(x 1) 2 3 4 12 y 7 4(x 1)2 Since the largest value of 7 4(x 1)2 will be when x 1 the maximum value of y 3 8x 4 x 2 will be y 7 when x 1 . Be able to sketch a curve with known stationary points. 1 1 1 1 1 1 1 7 2 3 4 5 6 1 3 6 10 15 21 1 1 4 10 20 35 1 5 15 35 1 6 21 The numbers in Pascal's Triangle also come from nCr 1 7 1 n! using appropriate r !(n r)! values of r and n. 61 Differentiation ..... 61 Notation ..... 61 Gradient Function ..... 61 Differentiation of powers of x and constant multiples, sums and differences. Solution x 2 6 x 8 0 (dividing by 2 to obtain an equation starting x2 ..) (x 3)2 (3)2 8 0 (x 3) 2 17 0 (x 3)2 17 x 3 17 x 3 17 x 1.12 or 7.12 (3 sf) 23 First Edition © C Morris. 7 Algebra..... Definite integrals Be able to find the area of a curve, given its gradient function and one point. If f (a) 0 then (x a) is a factor of f (x) If f ab 0 then (bx a) is a factor of f (x) That is to say dividing f (x) by (x a) or (bx a) respectively leaves no remainder! Example 1 Show that x 3 and x 2 are factors of x 3 3x 2 10 x 24 . Solution x2 4 x 3 0 (x 2)2 22 3 0 (x 2)2 7 0 (x 2)2 7 x 2 7 x 2 7 Sometimes you are asked to give answers in surd form (which will be exact as no decimal approximation will have taken place) but if you have to give decimal answers you can obtain them easily from here. (x 2)2 (y 3)2 36 is a circle with centre (2, 3) and radius 6. Example Find the equation of the tangent to the circle x 2 y2 6 x 8 y 0 at the point with coordinates (6, 8) . (x 3)2 (y 1)2 16 is a circle with centre (3,1) and radius 4. There are several approaches each of which needs you to have a gradient and a point that the line goes through. In the quadratic bracket on the right the constant must be 3 to give 6 when you multiply out. Example 4 Use the answer to example 2 to find the expansion in ascending powers of x up to and including the term in x 3 of (2 3x)(1 2 x)7 . Finding the Equation of a Tangent to a Circle This can be found by using the fact that the tangent to a circle is perpendicular to the radius of the circle. b 4 2 b2 (2 x 3 2 x2 x 3) (x 2)(2 x2 2 x c) d The terms that will have an x in come from 2 2x and cx . Discriminant When solving the quadratic equation ax 2 bx c 0, a 0 You know that the solutions (if there are any) are given by the quadratic equation formula x b b2 4ac 2a The part underneath the square root sign is called the discriminant, often given the symbol . 1 i.e. m1m2 1 . Algebra Manipulation of algebraic expressions Be able to simplify expressions including algebraic fractions, square roots and polynomials. Solution 7 6 x x 2 2 a (x b) 2 7 6 x x 2 2 a (x b)(x b) 7 6 x x 2 2 a (x 2 2bx b2) 7 6 x x 2 2 a b2 2bx x 2 Then compare the bits on the 2 sides. Do not forget Pythagoras' Theorem! Example Find the equation of the circle that has a diameter with endpoints (2, 4) and (4,8) Solution 2 (4) 4 8 The centre of the circle is at , 1, 2 2 2 The diameter of the circle is given by (4 2)2 (8 (4) 2 (6)2 12 2 180 36 5 6 5 The radius of the circle is therefore 6 5 3 5 2 The equation of the circle is therefore x (1) y 2 2 x 1 y 2 2 2 2 (3 5) 2 45 41 First Edition © C Morris. Be able to set up and solve problems leading to linear, quadratic and cubic equations in one unknown, and to simultaneous linear equations in two unknowns.

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