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**Chapter 1: Basic Arithmetic (P1)**

* Addition, subtraction, multiplication, and division of whole numbers, decimals, and fractions
* BODMAS

**Basic arithmetic** is the foundation of mathematics, and understanding it is essential for success in mathematics at higher levels. This chapter covers the fundamental operations of addition, subtraction, multiplication, and division for whole numbers, decimals, and fractions, as well as the use of the order of operations (BODMAS) to simplify expressions.

**Addition** is the operation of combining two or more numbers to get a total. For example, 3 + 4 = 7, where 3 and 4 are the addends and 7 is the sum.

**Subtraction** is the operation of taking away one number from another to find the difference. For example, 5 - 2 = 3, where 5 is the minuend, 2 is the subtrahend, and 3 is the difference.

**Multiplication** is the operation of repeated addition. For example, 3 × 4 = 12, which means that 3 is added four times to get 12.

**Division** is the operation of dividing a number into equal parts. For example, 12 ÷ 3 = 4, where 12 is the dividend, 3 is the divisor, and 4 is the quotient.

**BODMAS** is an acronym for the order of operations used in arithmetic: brackets, orders, division, multiplication, addition, and subtraction. It specifies the order in which operations should be performed in an expression. For example, in the expression 7 + 21 ÷ 3 × 7 - 7, we perform the division first, then multiplication, followed by addition and subtraction.

Example examination questions with solutions:

Evaluate 7 + 21 ÷ 3 × 7 - 7. (2012 Paper 1)

**Solution:**

First, we perform the division: 21 ÷ 3 = 7. Then, we perform the multiplication: 7 × 7 = 49. Next, we perform the addition: 7 + 49 = 56. Finally, we perform the subtraction: 56 - 7 = 49. Therefore, the answer is 49.

Evaluate 14 + 3(7 - 2) - 2 × 5. (2014 Paper 1)

**Solution:**

We first simplify the expression inside the brackets: 7 - 2 = 5. Then, we perform the multiplication: 3 × 5 = 15. Next, we perform the addition and subtraction from left to right: 14 + 15 - 2 × 5 = 14 + 15 - 10 = 19. Therefore, the answer is 19.

Evaluate 1 + 7 × 3. (2015 GCE Paper 1)

**Solution:**

We perform the multiplication first: 7 × 3 = 21. Then, we perform the addition: 1 + 21 = 22. Therefore, the answer is 22.

Find the value of 3 - 3 × 3 + 3. (2016 Paper 1)

**Solution:**

We perform the multiplication first: 3 × 3 = 9. Then, we perform the subtraction from left to right: 3 - 9 + 3 = -3. Therefore, the answer is -3.

**Additional exercises:**

Evaluate 9 + 2(5 - 1) ÷ 4.

**Solution:**

We first simplify the expression inside the brackets: 5 - 1 = 4. Then, we perform the division: 4 ÷ 4 = 1. Next, we perform the multiplication: 2 × 1 = 2.

Evaluate 5 + 6 × 2 ÷ 3 - 2.

**Solution:**

5 + 6 × 2 ÷ 3 - 2

= 5 + (6 × 2) ÷ 3 - 2 // Perform multiplication before division

= 5 + 4 - 2 // Perform division from left to right

= 7

Simplify 4 - (2 - 3) × 5.

**Solution:**

4 - (2 - 3) × 5

= 4 - (-1) × 5 // Evaluate the parentheses first

= 4 + 5

= 9

Evaluate 12 ÷ 4 - 2 × 3 + 5.

**Solution:**

12 ÷ 4 - 2 × 3 + 5

= 3 - 2 × 3 + 5 // Perform division before multiplication

= 3 - 6 + 5 // Perform multiplication before addition

= 2

Simplify 3 + (7 - 2) × 4 ÷ 2.

**Solution:**

3 + (7 - 2) × 4 ÷ 2

= 3 + 5 × 4 ÷ 2 // Evaluate the parentheses first

= 3 + 20 ÷ 2 // Perform multiplication before division

= 3 + 10 // Perform division from left to right

= 13

**Chapter 2: Algebra (P1 & P2)**

* Expressions and equations
* Factorization
* Simplification
* Solving equations

**Introduction:**

Algebra is a fundamental branch of mathematics that deals with symbols and the rules for manipulating those symbols. It involves expressions, equations, and functions that often use letters as placeholders for numbers.

**Chapter Overview:**

In this chapter, we will cover the basics of algebra including expressions, equations, factorization, simplification, and solving equations. We will start by introducing expressions and equations and how to manipulate them. Then, we will move on to factorization, which is the process of breaking down an expression into smaller factors. We will then discuss simplification of algebraic expressions, which involves combining like terms and using the distributive property. Finally, we will look at solving equations in x, which involves finding the values of x that satisfy an equation.

**Section 1: Expressions and Equations**

An algebraic expression is a combination of variables, constants, and operators. An equation is a statement that shows two expressions are equal. In this section, we will focus on expressions and equations in x.

Example:

3x + 4 is an example of an algebraic expression in x. It has a variable, x, a constant, 4, and an operator, +.

5x = 20 is an example of an equation in x. It shows that the expression 5x is equal to 20.

**Section 2: Factorization**

Factorization is the process of breaking down an expression into smaller factors. In this section, we will focus on factorization in x² format.

Example:

To factorize the expression 4x² - 12x + 9, we need to find two binomials whose product is equal to 4x² - 12x + 9. We can use the quadratic formula or trial and error to find the factors.

One possible way to factorize 4x² - 12x + 9 is (2x - 3)².

**Section 3: Simplification of Algebraic Expressions**

Simplification of algebraic expressions involves combining like terms and using the distributive property.

Example:

To simplify the expression 3x + 2(x - 5), we first distribute the 2 to get 3x + 2x - 10. Then, we combine like terms to get 5x - 10.

**Section 4: Solving Equations in x**

Solving equations in x involves finding the values of x that satisfy an equation. We can use algebraic manipulations to isolate x on one side of the equation.

Example:

To solve the equation 3x + 4 = 16, we first subtract 4 from both sides to get 3x = 12. Then, we divide both sides by 3 to get x = 4.

Exercises:

Simplify the expression 4x + 2y - 3x + 5y.

Factorize the expression x² - 5x + 6.

Solve the equation 2x - 5 = 11.

Simplify the expression 3(x - 2) - 2(x + 4).

Factorize the expression 9x² + 12x + 4.

Solution:

Simplify the expression 4x + 2y - 3x + 5y.

Combining like terms, we have:

4x - 3x + 2y + 5y = x + 7y

Therefore, the simplified expression is x + 7y.

Factorize the expression x² - 5x + 6.

To factorize the expression, we need to find two numbers that multiply to give 6 and add up to give -5. The two numbers are -2 and -3. Therefore, we can factorize the expression as:

(x - 2)(x - 3)

Solve the equation 2x - 5 = 11.

We want to isolate x on one side of the equation, so we need to add 5 to both sides:

2x - 5 + 5 = 11 + 5

2x = 16

Then, we need to divide both sides by 2:

2x/2 = 16/2

x = 8

Therefore, the solution is x = 8.

Simplify the expression 3(x - 2) - 2(x + 4).

Using distributive property, we have:

3x - 6 - 2x - 8

Combining like terms, we have:

x - 14

Therefore, the simplified expression is x - 14.

Factorize the expression 9x² + 12x + 4.

To factorize the expression, we need to find two numbers that multiply to give 9 x 4 = 36 and add up to give 12. The two numbers are 6 and 6. Therefore, we can factorize the expression as:

(3x + 2)(3x + 2), or simply (3x + 2)².

**Chapter 3: Indices (P1)**

* Laws of indices
* Scientific notation

Indices, or exponents, are a shorthand way of writing repeated multiplication of a number by itself. The number being multiplied is called the base, and the exponent (written as a superscript) tells us how many times the base is being multiplied by itself. For example, 5² means 5 multiplied by itself twice, or 25.

• Laws of indices: These are rules that help to simplify expressions involving indices. There are several different laws of indices, including the product law, quotient law, power law, and negative index law.

Laws of Indices:

Product Law: aᵐ × aⁿ = a^ (m+n)

Quotient Law: aᵐ ÷ aⁿ = a^ (m-n)

Power Law: (aᵐ) ⁿ = a^ (m×n)

Negative Exponent Law: a^ (-m) = 1/aᵐ

Zero Exponent Law: a⁰ = 1

• Scientific notation: This is a way of writing very large or very small numbers using powers of 10. It is commonly used in scientific and mathematical applications, where it is important to express numbers in a concise and meaningful way.

Scientific Notation is a way of writing very large or very small numbers using powers of 10. A number is written in scientific notation when it is written as a decimal between 1 and 10 multiplied by a power of 10. For example, 300,000 can be written as 3 × 10⁵ in scientific notation.

Example Questions:

Simplify the expression 3² × 3³.

Solution: Using the product law, we can add the exponents: 3² × 3³ = 3^(2+3) = 3⁵ = 243.

Evaluate the expression (4² × 10⁴) ÷ (2³ × 5).

Solution: Using the quotient law, we can subtract the exponents: (4² × 10⁴) ÷ (2³ × 5) = 2^(2-3) × 10^(4-1) = 2⁻¹ × 10³ = 0.5 × 10³ = 500.

Write the number 0.000025 in scientific notation.

Solution: 0.000025 can be written as 2.5 × 10⁻⁵ in scientific notation.

Write the number 6.02 × 10²³ in standard notation.

Solution: 6.02 × 10²³ = 602,000,000,000,000,000,000,000, which can also be written as 6.02 x 10^23.

Simplify the expression 3⁴ ÷ 3² × 3³.

Solution: Using the product and quotient laws, we can simplify as follows: 3⁴ ÷ 3² × 3³ = 3^(4-2) × 3³ = 3⁵ = 243.

Additional Exercises:

Evaluate the expression 8⁴ ÷ 2².

Simplify the expression (5⁻²)³ × 5⁻⁴.

Convert the number 1.5 × 10⁷ into standard notation.

Write the number 0.00045 in scientific notation.

Evaluate the expression 2³ × 5² ÷ 2² × 5³.

Solution:

Evaluate the expression 8⁴ ÷ 2²:

We can simplify the expression as follows:

8⁴ ÷ 2² = (2³)⁴ ÷ 2² = 2¹² ÷ 2² = 2¹⁰

Therefore, 8⁴ ÷ 2² = 1024.

Simplify the expression (5⁻²)³ × 5⁻⁴:

We can simplify the expression as follows:

(5⁻²)³ × 5⁻⁴ = 5⁻⁶ × 5⁻⁴ = 5⁻¹⁰

Therefore, (5⁻²)³ × 5⁻⁴ = 1/5¹⁰ = 0.0000000001.

Convert the number 1.5 × 10⁷ into standard notation:

The number 1.5 × 10⁷ can be written in standard notation as follows:

1.5 × 10⁷ = 15,000,000

Write the number 0.00045 in scientific notation:

We can write the number 0.00045 in scientific notation as follows:

0.00045 = 4.5 × 10⁻⁴

Evaluate the expression 2³ × 5² ÷ 2² × 5³:

We can simplify the expression as follows:

2³ × 5² ÷ 2² × 5³ = (2³ ÷ 2²) × (5² ÷ 5³) = 2 × 1/5 = 2/5

Therefore, 2³ × 5² ÷ 2² × 5³ = 2/5.

**Chapter 4: Coordinate Geometry (P1)**

* Cartesian plane
* Slope of a line
* Midpoint formula

The Cartesian plane is a 2-dimensional coordinate system that consists of an x-axis and a y-axis, which intersect at the origin (0, 0). Each point on the plane can be represented by an ordered pair (x, y), where x is the distance from the y-axis, and y is the distance from the x-axis.

The slope (or gradient) of a line is a measure of how steep it is and can be calculated as:

m = (y₂ - y₁)/(x₂ - x₁)

Where (x₁, y₁) and (x₂, y₂) are two points on the line. A line with a positive slope slopes upwards from left to right, while a line with a negative slope slopes downwards from left to right. A horizontal line has a slope of 0, while a vertical line has an undefined slope.

The midpoint formula is used to find the coordinates of the midpoint of a line segment joining two points (x₁, y₁) and (x₂, y₂) and is given by:

((x₁ + x₂)/2, (y₁ + y₂)/2)

To find the distance (d) between two points (x₁, y₁) and (x₂, y₂), we use the distance formula:

d = √ ((x₂ - x₁)² + (y₂ - y₁)²)

**Example question:**

1. The line passing through the points (4, 3) and (-2, 7) has a slope of -2. Find the equation of the line in the form y = mx + c, where m is the slope and c is the y-intercept.

**Solution:**

Using the slope formula:

m = (y₂ - y₁)/(x₂ - x₁)

-2 = (7 - 3)/ (-2 - 4)

-2 = 4/-6

-2/1 = 4/6

We can use the point-slope form of the equation of a line to find the equation:

y - y₁ = m(x - x₁)

y - 3 = (-2/3) (x - 4)

y = (-2/3) x + 10

Therefore, the equation of the line in the form y = mx + c is y = (-2/3) x + 10.

1. The gradient of joining the points (-2, k) and (k,-14) is 2. What is the value of k?

**Solution:**

We can use the formula for finding the slope (gradient) of a line passing through two points:

Slope = (y₂ - y₁) / (x₂ - x₁)

Let's substitute the given points and the slope into the formula:

2 = (-14 - k) / (k - (-2))

Simplifying this equation, we get:

2 = (-14 - k) / (k + 2)

2(k + 2) = -14 - k

2k + 4 = -14 - k

3k = -18

k = -6

Therefore, the value of k is -6.

1. The diagram below shows a Cartesian plane with points A (6, 6), B (0,-2), C (0, 6) and D (6, 0). Find the (a) equation of the line CD (b) distance AB

To find the equation of line CD, we need to first find the slope of the line.

Slope of line CD = (y2 - y1)/(x2 - x1) where (x1, y1) = (0, 6) and (x2, y2) = (6, 0)

Slope of line CD = (0 - 6)/ (6 - 0) = -1

Now, we can use the point-slope form of the equation of a line to find the equation of line CD.

Using point (0, 6) and slope -1, we have:

y - 6 = -1(x - 0)

y - 6 = -x

y = -x + 6

Therefore, the equation of line CD is y = -x + 6.

To find the distance AB, we can use the distance formula:

AB = √ ((x2 - x1) ^2 + (y2 - y1) ^2) where (x1, y1) = (6, 6) and (x2, y2) = (0, -2)

AB = √ ((0 - 6) ^2 + (-2 - 6) ^2)

AB = √ (36 + 64)

AB = √ (100)

AB = 10

Therefore, the distance AB is 10.

1. The line passes through the points A (3, 2) and B (5, y) has a gradient -2. Find the value of y

gradient = (y2 - y1) / (x2 - x1)

gradient = (y - 2) / (5 - 3) = -2

(y - 2) / 2 = -2

y - 2 = -4

y = -2

Therefore, the value of y is -2.

1. Find the gradient of a line which passes through (-5 3) and (-4 1)

**Solution:**

The gradient of a line passing through two points (x1, y1) and (x2, y2) is given by:

m = (y2 - y1) / (x2 - x1)

Here, the two points are (-5, 3) and (-4, 1). So,

m = (1 - 3) / (-4 - (-5)) = (-2) / (1) = -2

Therefore, the gradient of the line passing through (-5, 3) and (-4, 1) is -2.

1. A and B are Coordinates (-3, 3) and (5, 9) respectively. Find the length AB

**Solution:**

We can use the distance formula to find the length AB:

d = √ ((x2 - x1) ^2 + (y2 - y1) ^2)

Where (x1, y1) and (x2, y2) are the coordinates of A and B, respectively.

Plugging in the values, we get:

d = √ ((5 - (-3)) ^2 + (9 - 3) ^2)

= √ (8^2 + 6^2)

= √ (64 + 36)

= √ (100)

= 10

Therefore, the length AB is 10.

1. In the diagram below A is the point (0, 4) and B is the point (2, 0) and O is the origin. Find the equation of the straight line passing through O parallel to line AB

**Solution:**

To find the equation of the straight line passing through O parallel to line AB, we first need to find the slope of line AB.

The slope of line AB is given by:

slope = (y2 - y1) / (x2 - x1)

Where (x1, y1) = (0, 4) and (x2, y2) = (2, 0)

slope = (0 - 4) / (2 - 0)

slope = -2

Since the line passing through O is parallel to line AB, it will have the same slope as line AB.

Therefore, the equation of the straight line passing through O with a slope of -2 is given by:

y - y1 = m(x - x1)

Where (x1, y1) = (0, 0) and m = -2

y - 0 = -2(x - 0)

y = -2x

Hence, the equation of the straight line passing through O parallel to line AB is y = -2x.

1. Convert the number 1.5 × 10⁷ into standard notation.

**Solution:**

1.5 × 10⁷ = 15,000,000

1. Write the number 0.00045 in scientific notation.

**Solution:**

0.00045 = 4.5 × 10⁻⁴

1. Evaluate the expression 2³ × 5² ÷ 2² × 5³.

**Solution:**

2³ × 5² ÷ 2² × 5³ = (2 × 2 × 2) × (5 × 5) ÷ (2 × 2) × (5 × 5 × 5) = 40 ÷ 1000 = 0.04

**Practice Questions:**

1. Find the equation of the line passing through the points (1,2) and (3,4).

**Solution:**

The gradient of the line is m = (4 - 2)/ (3 - 1) = 1. The line passes through point (1,2), so using point-slope form, the equation of the line is y - 2 = 1(x - 1), which simplifies to y = x + 1.

Find the midpoint of the line joining the points (-2, 3) and (4,-1).

**Solution:**

The midpoint of the line is the average of the x-coordinates and the average of the y-coordinates of the two points. So, the midpoint is ((-2 + 4)/2, (3 + (-1))/2) = (1, 1).

1. Find the gradient of the line passing through the points (0, 5) and (-3,-1).

**Solution:**

The gradient of the line is m = (-1 - 5)/(-3 - 0) = -2.

1. Find the length of the line joining the points (2, 5) and (-3,-1).

**Solution:**

Using the distance formula, d = √ ((2 - (-3)) ² + (5 - (-1)) ²) = √ (5² + 6²) = √61.

Chapter 5: Functions (P1)

* Graphing functions
* Inverse functions
* Domain and range

Chapter 6: Set Notation (P1)

* Union, intersection, and complement of sets
* Venn diagrams

Chapter 7: Estimation (P1)

* Rounding off
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Chapter 8: Matrices (P1 & P2)

* Addition and subtraction
* Multiplication
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Chapter 9: Sequences (P1 & P2)

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* Direct and inverse proportion
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* Bearings and angles
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* Area and perimeter of basic shapes
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Chapter 15: Trigonometry (P1 & P2)

* Basic trigonometric ratios
* Solving right-angled triangles
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Chapter 16: Circle Theorem (P1)

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Chapter 21: Graphs of Functions (P1)

* Linear functions
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Chapter 22: Time Graphs (P1)

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* Probability of events
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* Reflection, rotation, and translation
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* Quadratic formula
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* Basic constructions
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Chapter 27: Vector Geometry (P2)

* Vector equations of lines and planes
* Scalar and vector products

Chapter 28: Statistics (P2)

* Measures of central tendency
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Chapter 29: Quadratic Function (P2)

* Quadratic function properties
* Quadratic function graphs