**Unit 5**

**The Real Number System**

**Topic A: Rational and irrational numbers**

* Real numbers

**Topic B: Properties of addition and multiplication**

* Properties of addition
* Properties of multiplication
* Properties of addition & multiplication

**Topic C: Signed numbers and absolute value**

* Signed numbers
* Absolute value

**Topic D: Operations with signed numbers**

* Adding and subtracting signed numbers
* Multiplying signed numbers
* Dividing signed numbers

**Unit 5 Summary**

**Unit 5: Self - test**

**Topic A: Rational and Irrational Numbers**

**Real Numbers**

**Natural numbers:**  the numbers used for counting. 1, 2, 3, 4, 5, 6 …

**Whole numbers:** the natural numbers plus 0. ***0***, 1, 2, 3, 4, 5, 6 …

**Integers:**  all the whole numbers and their negatives. ***… -4, -3, -2, -1***, 0, 1, 2, 3, 4 …

**Rational number:** a number that can be expressed as a fraction of two integers().

**Examples** of rational numbers:

, ， 11， 0 ， 0.52 ， -4.5 **(=**, (=2)

Rational numbers can be expressed as terminating decimals or repeating decimals.

**Example**: = 0.75 A terminating decimal.

= 0.66666… = A repeating decimal.

0.232323… = A repeating decimal.

**Irrational number:** anumber that ***cannot*** be represented by the fractions of two integers.

**Examples** of irrational numbers: π , , ,

Irrational numbers ***cannot*** be expressed as terminating decimals or repeating decimals.

π 3.14159265358979323… A non-terminating and non-repeating decimal.

A non-terminating and non-repeating decimal.

**Real numbers (*R*):** rational numbers plus irrational numbers.

**The real number system:**

Real Numbers

Rational numbers

Integers Irrational

Whole numbers numbers

Natural numbers

**Topic B: Properties of Addition and Multiplication**

**Properties of Addition**

**Commutative property:** changing the order of the numbers does not change the sum (order does not matter).

***a*** + *b* = *b +* ***a* Example**: **2** + 3 = 3 + **2** 5 = 5

**Associative property:** regrouping the numbers does not change the sum (it does not matter where you put the parenthesis).

**(***a* + *b***)** *+ c* = *a +* **(***b* ***+ c*)Example**:  **(**2 + 1**)** + 3 = 2 + **(**1 + 3**)**  5 = 5

**Additive identity property:** the sum of any number and zero leaves that number unchanged. ***a*** + 0 = ***a* Example**: **100** + 0 = **100**

**Closure property of addition:** the sum of any two real numbers equals another real number. **Example**: If **3** and **8** are real numbers, then 3 + 8 = **11** is another real number.

**Additive inverse property:** the sum of any real number and its negative is always a zero. -*a* + *a* = **0** **Example**: 7 + (-7) = **0**

**A summary of properties of addition:**

|  |  |
| --- | --- |
| **Additive Properties Example** | |
| **Commutative property** (switch order) | *a* + *b* = *b + a* 2 + 3 = 3 + 2 |
| **Associative property**  (switch parentheses) | (*a* + *b*) *+ c* = *a +* (*b + c*)(2 + 1) + 3 = 2 + (1 + 3) |
| **Identity property** | *a* + 0 = *a* 100 + 0 = 100 |
| **Closure property** | If *a* and *b* are real numbers, 2 and 5 are real numbers, so  then *a* + *b* is a real number. 2 + 5 = 7 is a real number. |
| **Inverse property** | -*a* + *a* = 0 -2 + 2 = 0 |

**Example**:Name the properties. **Answer**

1. 7 *x* + 0 = 7*x* Identity property
2. (97 + 22) + 3 = (97 + 3) + 22 Commutative property (switch order)
3. (3 + 11*x*) + 7*x* = 3 + (11*x* + 7*x*) Associative property (switch parentheses)
4. (4*y* + 3) + [-(4*y* + 3)] = 0 Inverse property of addition

**Properties of Multiplication**

**Commutative property:** changing the order of the numbers does not change the product (order does not matter). ***a*** *b* = *b* ***a***

**Example**: **2** ∙ 6 = 6 ∙ **2**  12 = 12

**Associative property:** regrouping the numbers does not change the product (it does not matter where you put the parenthesis). **(***a* *b***)** *c* = *a* **(***b c***)**

**Example**: **(**2 ∙ 4**)** ∙ 3 = 2 ∙ **(**4 ∙ 3**)**  24 = 24

**Multiplicative identity property:** a number does not change when it is multiplied by 1.

**Example**: 9 ∙ **1** = 9 ***a*** ∙ 1 = ***a***

**Distributive property:**  multiply the number outside the parenthesis by each of the numbers inside the parenthesis. ***a*** (*b + c*) = ***a****b* **+ *a****c* or ***a*** (*b – c*) = ***a****b**–* ***a****c*

**Example**: **2** (3 + 4) = **2** ∙ 3 + **2** ∙ 4 14 = 14

**5** (6 *–* 3) = **5** ∙ 6 *–* **5** ∙ 3 15 = 15

**Multiplicative property of zero:** any number multiplied by zero always equals zero.

**Example**: 100∙ **0** = **0 *a*** ∙ 0 = **0**

**Closure property of multiplication:** the product of any two real numbers equals another real number.

**Example**: If **5** and **4** are real numbers, then 5 ∙ 4 = **20** is another real number.

**Multiplicative inverse property:** the product of any nonzero real number and its reciprocal is always one. = 1

**Example**: **1)** 

**2)** )= 1

Recall reciprocal: Reciprocal =

For example, the reciprocal of 4 is

number its reciprocal

**A summary of properties of multiplication:**

|  |  |
| --- | --- |
| **Multiplicative properties Example** | |
| **Commutative property**  (Switch order) | ***a*** *b* = *b* ***a*  2** ∙ 3 = 3 ∙ **2** |
| **Associative property**  (Switch parentheses) | **(***a* *b***)** *c* = *a* **(***b c***)**  **(**2 ∙ 1**)** 3 = 2 **(**1 ∙ 3**)** |
| **Identity property of 1** | ***a*** ∙ 1 = ***a***  **100** ∙ 1 = **100** |
| **Closure property** | If *a* and *b* are real numbers, **3** and **4** are real numbers, so  then *ab* is a real number. 3 (4) = **12** is a real number |
| **Distributive property** | ***a*** (*b + c*) = ***a****b* **+ *a****c* **2** (3 + 4) = **2** ∙ 3 + **2** ∙ 4  ***a*** (*b – c*) = ***a****b**–* ***a****c* **3** (4 *–* 2) = **3** ∙ 4 *–* **3** ∙ 2 |
| **Property of zero** | ***a*** ∙ 0 = **0 35** ∙ 0 = **0** |
| **Inverse property** |  |

**Example**:Name the properties **Answer**

1. (3*y*) (5*y*) = (5 ∙ 3) (*y* ∙ *y*) Commutative property of multiplication

= 15 *y*2

1. (9 *x*) *x*2 = 9 (*x* ∙ *x*2) Associative property of multiplication

= 9 *x*3

1. (10 *x –* 15) = ∙ 10 *x –* ∙ 15 Distributive property of multiplication

= 2 *x* – 3

1. ( Inverse property of multiplication
2. (2*x* – 3*y*) *x* = 2*x*2 – 3*xy* Distributive property
3. *∙* 0 = 0 Multiplicative property of zero
4. (1000 8) 9 = 1000 (8 9) Associative property of multiplication

= 1000 (72) = 72000

**Properties of Addition & Multiplication**

**Properties of addition and multiplication:**

|  |  |  |
| --- | --- | --- |
| **Name** | **Additive properties** | **Multiplicative properties** |
| **Commutative property** | ***a*** + *b* = *b +* ***a*** | ***a*** *b* = *b* ***a*** |
| **Associative property** | **(***a* + *b***)** *+ c* = *a +* **(***b* ***+ c*)** | **(***a* *b***)** *c* = *a* **(***b c***)** |
| **Identity property** | ***a*** + 0 = ***a*** | ***a*** ∙ 1 = ***a*** |
| **Closure property** | If *a* and *b* are real numbers,  then *a* + *b* is a real number. | If *a* and *b* are real numbers,  then *a* ∙ *b* is a real number. |
| **Inverse property** | -*a* + *a* = 0 |  |
| **Distributive property** |  | ***a*** (*b + c*) = ***a****b* **+ *a****c* |
| **Property of zero** |  | ***a*** ∙ 0 = **0** |

**Example:** Regroup and simplify the calculations using properties.

* + 1. (43 + 1998) + 2 = ?

43 + (1998 + 2) = 2043Associative property of addition

* + 1. (7 1000) 9 = ?

(7 1000 = 63,000Commutative property of multiplication

**Example:** Solving the problems in two ways.

**1)** 3 (4 + 2) = ?

**a)** 3 6 = 18

**b)** 3 4 + 32 = 18Distributive property

**2)**

**a)** =

=

**b)** Distributive property

= = =