**Key Ideas/concepts/Processes**

* **Number System:** Number system is how we represent how many items are there (e.g. there are **21** blue cars in the parking lot). The number 21 was arrived at because the blue cars being tallied were counted in groups of 10. Therefore, a number system is the technique used to group items being tallied.
* **Base Number**: Each group created during tallying has the same number of items. This number of items used to create groups during tallying is called the **base number** of the Numbering System. (That is, a base 10 number systems means that every 10 items during tallying will create a new group; a base 8 number system means that every 8 items will created a new group).
* **Group Levels:** The total number of items tallied (counted) is written using the remainder values of each grouping level
* The digits shown are remainder values of each group level. (Example: in a base 10 number system, the number 432 means the digit 2 is the remainder for 0 grouping level—no groups level; the digit 3 is the remainder for 1st grouping level—when counting items that were in groups of 10s; the digit 4 is the remainder of 2nd grouping level—when counting items that were in groups of 100s

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| --- | --- | --- | --- | --- |
|  | **Column 4** | **Column 3** | **Column 2** | **Column 1** |
| **Tallying Groups** | **3rd Grouping level**  |  **2nd Grouping level** | **1st Grouping level** | **No groups** |
| **43210** |  | **4** | **3** | **2** |
| **53678** | **5** | **3** | **6** | **7** |
| **405** |  |  | **4** | **0** |

* **Place Values:** is calculated by raising the base number to the power of the group level (based on the grouping level). The place value represents how many items a 1 represents in that particular column

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| --- | --- | --- | --- | --- |
|  | **Column 4** | **Column 3** | **Column 2** | **Column 1** |
| **Tallying Groups** | **3rd grouping levels** | **2nd grouping levels** | **1st grouping level** | **No groups** |
| **Group Level**  | **3** | **2** | **1** | **0**  |
| **43210 place values** |  | **102 = 100** | **101 = 10** | **100 = 1** |
| **53678 place values** | **83 = 512** | **82 = 64** | **81 = 8** | **80 = 1** |
| **405 place values** |  |  | **51 = 5** | **50 = 1** |

* In any number system, all the digits are lower than the base number. The biggest/largest digit has the value = (Base Number -1). For example, for a base 10 number system, the largest digit value = 10 -1 ⇒ 9; for base 3 number system has the largest digit value = 3 - 1 ⇒ 2.
* “Complement “ is what is need to complete/make whole
* **Column Complement**: is the amount/value that is required to make a digit in each column become the largest/biggest digit in that particular numbering system.

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| --- | --- | --- | --- | --- |
| **Number/col. complement** | **Column 4** | **Column 3** | **Column 2** | **Column 1** |
| 43210column complement  |  | 4→9 = 55 | 3→9 = 66 | 2→9 = 77 |
| 53678column complement | 5→7 = 22 | 3→7 = 44 | 6→7 = 11 | 7→7 = 00 |
| 405column complement |  |  | 4→4 = 00 | 0→4 = 44 |

* **Radix Complement** is the amount/value that is required to **add to** the current number to generate a number that has the left-most column as 1 and the rest of the columns have a digit of 0 (you have as many 0-digits as there are in the original number).

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| --- | --- | --- | --- |
| **Number** | **Column****Complement** | **Column Complement + 1** | **Radix Complement** |
| 43210 | 432 → 999 = 567 | 567 + 1 = 568 | 432 → 1000 = ? |
| 53678 | 5367 → 7777 = 2410 | 2410 + 1 = 2411 | 5367 → 10000 = ? |
| 405 | 40 → 44 = 4 | 4 + 1 = 10 | 40 →100 = ? |
| NOTE: remember that any digit of the number system may not be bigger or equal to the base number of the number system |

* **2s Complement:** In a base 2 number system (binary number system), which computers use, a radix complement is called a 2s Complement.
* **1s Complement:** In a binary number system, a column complement is called a 1s Complement.
* **Digits-** use alphanumeric digits for number systems grouping items more than 10 items (e.g. Base 16 uses 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, A, B, C, D, E, F as its digits).

**Student Questions**

1. Write tallied (counted) items in specified number system using the correct conversion for number system.
2. Add and/or subtract integers in any given number system.
3. Calculate the place values of digits in any number system.
4. Calculate column complements of a number in any given number system.
5. Calculate radix complement of a number in any given number system
6. Subtract two numbers using a radix complement method
7. Define/explain the following in your own terms: (a) Number system, (b) Base Number, (c) Places values, (d) 2s complement, and (e) 1s complement.
8. Describe binary and hexadecimal numbers