***ChemMatters* Puzzle: Chemical Ken-Ken Puzzle**

Like its big brother SUDOKU, KEN-KEN is a logic game from Japan. In 4x4 grid on the left, your objective is to fill the digits 1–4 so that each appears **exactly once** in each row and each column.

Notice that most boxes are part of a cluster. In the upper-left corner of each multibox cluster is a value that is the SUM of its numbers. For example, if that value is 3 for a two-box cluster, you know that only 1 and 2 can go in there. But it is your job to determine which number goes where! A few clusters may have just one box, and that is the number that fills that box.

We will help you solve this warm-up puzzle or you can cover up our completed version to try it on your own!

  **WARM-UP PUZZLE SOLUTION**

 A B C D

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 1 | 5+ |  | 7+ | 8+ |  | 5+  **2** |  **3** | 7+ **4** | 8+  **1** |
|  2 | 3+ |  |  |  | 3+  **1** |   **2** |   **3** |   **4** |
| 3 | 11+ | 1 | 3+ |  | 11+  **4** | 1  **1** | 3+  **2** |  **3** |
| 4 |  |  |  | 2 |   **3** |   **4**  |   **1** |  2 1.
 |

1. The single-box cluster at D4 contains a 2. Where is the other single cluster, and what digit goes there?
2. The three boxes in the upper-right corner total 8. There are just three ways to achieve that: 1+3+4, 2+2+4, and 3+3+2 (in any order). But since you *cannot* repeat a number in column four, two ways are eliminated!
3. Such number logic will also let you set the bottom left-hand corner cluster of three boxes. Try it!
4. Once three digits are in place in any row or column, the fourth must follow.

It likely will not take you long to complete the puzzle. More difficult puzzles use a 5x5 grid filled with the digits 1,2,3,4, and 5, or 6x6 with 1, 2, 3, 4, 5, and 6, etc. They may also use more than one kind of math operation.

On the next page we show you a variant called CHEMICAL KEN-KEN. It is played on a 5x5 grid and uses multiplication rather than addition, along with some knowledge of the elements and the periodic table. Have fun in solving it!

The **Chemical Ken-Ken** is a 5x5 grid so the digits are 1, 2, 3, 4, and 5. And the values are obtained by multiplying them instead of adding them. For example, a three-box cluster containing 3, 3, and 5 would show a value of 45. Note that *that* set of factors is the *only* way for a three-box cluster to have a value of 45. Any cluster containing the number 5 must yield a product that ends in either 5 or 0.

In this blank grid, we represent the value with a letter. Below the grid is a group of clues about chemical elements. As you decipher each clue, transfer that atomic number to the grid and then proceed as you did on the first page. For example, if you think the element labeled (a) is oxygen (which it isn't…), you would put 8 beside “a” in the grid. The more clues you can decipher the first time, the more easily you can determine the values of the other numbers. You can also work backward to deduce a missing atomic number, knowing the numbers at play.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **a** |  |  **b**  | **c**  |  |
| **d** |  | **e** |  |  |
| **f** | **g**  |  | **h** |  |
|  |  | **i**  |  |  **j** |
| ***k***  |  | ***l***  |  |  |

CLUES

Identify the **atomic numbers** of the following 12 elements as best you can. A few appear more than once. Then transfer it to the corner of the box in the grid holding that letter.

a A not-too-dense but tough metal, sometimes used in flares.

b The most common element in a star.

c The first metal to have both its *3d* and *4s* subshells filled in its ground state.

d The second-most common element in a star.

e This group-2 metal is predominant in quick lime, lime water, and limestone.

f Besides oxygen and carbon, a key element in the spiral ”backbone” of DNA

 (but not the nucleic acids that make up the “rungs”).

g In a periodic table, this element occupies period 5, group 4.

h This alkali metal has the strongest drive to be oxidized, measured by Eox values.

i Its boiling point is a very cold 4.1 K.

j This metal’s carbonate salt has a molar mass of 100.

k The one element in the alkaline-earth group that is *not* a true metal.

l Graphite is one of the allotropes of this element.

**Answers to the *ChemMatters* Puzzle**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **a 12 4**  |  **3**  | b **1****1**  | **c** 30 **5** |  **2**  |
| d 2**2**  |  **1**  | 20 **e** **5**  |  **4**  |  **3**  |
|  **f 15****5**  | **g 40****2**  |  **4**  | **h 3 3**  |  **1**  |
|  **3**  | **5** | **i 2****2**  |  **1**  | **j 20****4**  |
| ***k*** 4**1**  |  **4**  | ***l 6*****3**  |  **2**  | **5** |

The numbers in the upper-right corner of each cluster match the clues given on the previous page.

Here are the **atomic numbers** and **symbols** and clues for the 12 entries.

a 12 Mg A not-too-dense but tough metal, sometimes used in flares.

b 1 H The most common element in a star.

c 30 Zn The first metal to have both its *3d* and *4s* subshells filled in its ground state.

d 2 He The second-most common element in a star.

e 20 Ca This group-2 metal is predominant in quick lime, lime water, and limestone.

f 15 P Besides oxygen and carbon, a key element in the backbone spirals of DNA.

g 40 Zr In a periodic table, this element occupies period 5, group 4

h 3 Li This alkali metal has the strongest drive to be oxidized, measured by Eox values.

i 2 He Its boiling point is a very cold 4.1 K.

j 20 Ca This metal’s carbonate salt has a molar mass of 100.

k 4 Be The one element in the alkaline-earth group that is *not* a true metal.

l 6 C Graphite is one of the allotropes of this element.