

4 Chalice (ABCD) The Real Chalice is 101<sup>st</sup> in the sequence  
ABCDCBABCDCB.... **The Real Chalice is Chalice C.**

### Solution

**A<sub>1</sub> B<sub>2</sub> C<sub>3</sub> D<sub>4</sub> C<sub>5</sub> B<sub>6</sub> A<sub>7</sub> B<sub>8</sub> C<sub>9</sub> D<sub>10</sub> C<sub>11</sub> B<sub>12</sub>  
A<sub>13</sub>...**

There are a variety of ways to solve this problem.

### Counting

Just simply count it all out to 101. Humans are slow at this. Computers are much quicker and better (when instructed correctly). This is fine for 101. What about 246 or 1111?

### Pattern Recognition #1

Once you remove the first 4 terms of the sequence (ABCD), there is a repeating pattern of [CBA], [BCD], [CBA] [BCD], etc. thereafter. Where does 97<sup>th</sup> in the sequence appear?

The pattern repeats after 6 terms : [CBA] then [BCD].

97 divided by 6 gives 16 full patterns and a remainder of 1.

So once we have counted 16 repetitions, the 1<sup>st</sup> term that comes next must be the real chalice. This is chalice C.

### Pattern Recognition #2

The first 6 terms ABCDCB form a repeating pattern. So 101 divided by 6 is 16 with a remainder of 5. The 5<sup>th</sup> term in the next repetition of the pattern is C. The real chalice is C.

(Please review the **Key Notes** below before proceeding)

## Key Notes

1. Before proceeding to an abstraction and a general solution, discuss the **advantages** and **disadvantages** of each solution described.

Which solution would you use to help develop an algorithm or an automated solution?

2. Finding the remainder of a number after division is part of a topic in Maths called Modular Arithmetic.

The remainder of 101 divided by 6 is 5.

This is expressed as  $101 \bmod 6 \equiv 5$ . Modular arithmetic is a vital ingredient to some encryption methods and internet security.

Check out [RSA encryption explained with Khan Academy](#) and [Young Scientist winner Sarah Flannery](#).