Problem of the Week
Problem A and Solution
Following Directions

Problem

Yeni is playing a game that uses a 12×12 grid like the one shown below. She moves pieces on the grid by giving a sequence of steps. Each step is a direction indicated by an arrow: $\uparrow$ (up one block), $\downarrow$ (down one block), $\leftarrow$ (left one block), and $\rightarrow$ (right one block).

Yeni has a special move which combines six steps: $\rightarrow \quad \rightarrow \quad \downarrow \quad \downarrow \quad \leftarrow \quad \uparrow$

A) Yeni starts by putting a marker (**X**) at position A1.

   What is the position of the marker after making the special move three times in a row?

B) How many more times can she repeat the special move before the marker will move off the grid?

Solution

A) Starting at position A1, after making the special move once, the marker ends up at position B2.

	A	B	C	D	E	F	G	H	I	J	K	L
1	$\rightarrow$	$\rightarrow$	$\downarrow$									
2		**X**	$\downarrow$									
3		$\uparrow$	$\leftarrow$									
4												
5												
6												
7												
8												
9												
10												
11												
12												

   Each time Yeni uses the special move, the marker ends up one row below and one column to the right of its starting position. So after the second time she executes the move, the marker moves to position C3, and after the third time she executes the move, the marker moves to position D4.

B) If we continue repeating this pattern, after the 10th time she repeats the move, the marker moves to position K11. From that position, if Yeni tries the special move she can move to the right once safely. However if she tries to move to the right a second time that would mean the marker moves off the edge of the grid. This means that starting from position A1 Yeni can repeat the special move 10 times safely, or 7 more times after using the special move 3 times.

Teacher's Notes

This question was inspired by *turtle graphics* and *Karel the Robot*. In the 1960s, the programming language Logo allowed coders to use a turtle robot to draw patterns on the screen. The turtle normally appeared as a simple triangle, which indicated a direction it would move next. Programmers could easily write programs that would make the turtle move forward, turn, and draw lines. With a small set of instructions, people could create very interesting patterns and geometric images on the screen. Karel the Robot was designed to teach students how to code by having them control a simple, graphical robot that could move around a grid on the screen. Karel only responded to a small set of instructions, but this was enough to teach and learn the essential concepts of computer programming. Both the Logo turtle and Karel the Robot have been replicated in more modern programming languages.

This problem demonstrates two of those essential programming concepts: *modularization* and *repetition*. When writing programs of any size, it is important to be able to break up the problem into smaller subproblems. Programmers will bundle instructions together into subprograms, that are often referred to as functions, procedures, subroutines, or methods. Identifying these smaller pieces of the problem makes them easier to solve, and the code used to solve them more flexible.

Having the ability to repeat instructions in code, leads to more and better solutions to the problems that can be solved by computers. It can be tricky for new programmers to use repetition properly. Knowing when and how to stop the repetition is essential to success in coding.