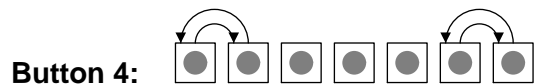
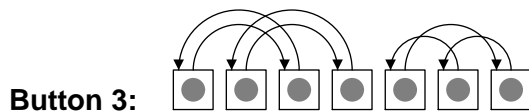
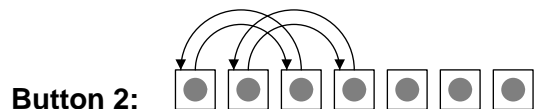
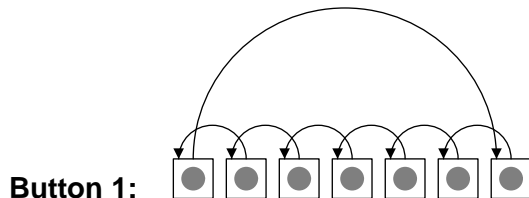


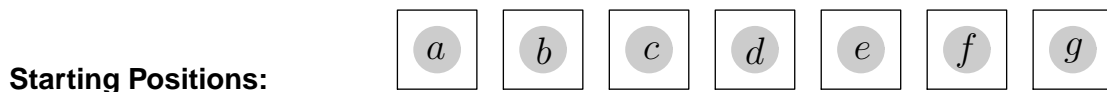
# Permutations All-Day Sprint Math Meet 2006

## The Set-up

In this Sprint, there are seven boxes and four buttons which rearrange the contents of those boxes. When you press the buttons, they move the contents as shown by the arrows in the figures below:



The boxes will begin with the letters  $a$  through  $g$  as their contents, in order from left to right as shown in this figure:

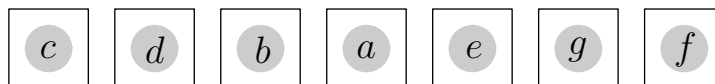


## The Question

Beginning with the letters  $a$  through  $g$  in the boxes as displayed above in the figure labelled “Starting Positions”, you *want* to get the letters to be in the positions shown below using some combination of button presses.

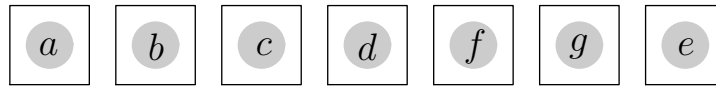
Write, in order, a sequence of button presses that will result in the desired arrangement. Or, if it is not possible to obtain the desired arrangement using the buttons, check the “Not Possible” box. The first one is done for you as a demonstration. *When selecting a winner, we will give preference to answers that are not only correct but also use a minimum number of button presses to achieve the desired arrangement.*

1.



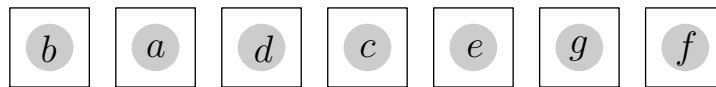
- This arrangement can be obtained using the sequence of buttons 4  $\mapsto$  2 \_\_\_\_\_
- This arrangement cannot be obtained using buttons 1 through 4.

2.



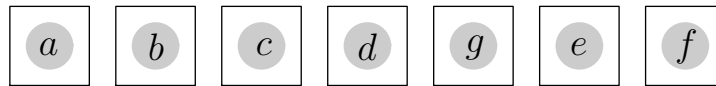
- This arrangement can be obtained using the sequence of buttons  $2 \mapsto 3$  \_\_\_\_\_  
 This arrangement cannot be obtained using buttons 1 through 4.

3.



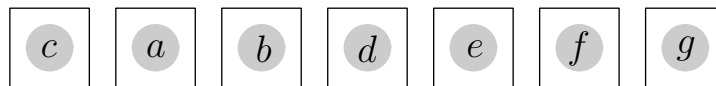
- This arrangement can be obtained using the sequence of buttons \_\_\_\_\_  
 This arrangement cannot be obtained using buttons 1 through 4.

4.



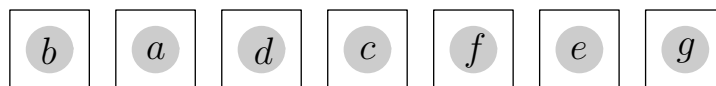
- This arrangement can be obtained using the sequence of buttons  $3 \mapsto 3 = 3^2$  \_\_\_\_\_  
 This arrangement cannot be obtained using buttons 1 through 4.

5.



- This arrangement can be obtained using the sequence of buttons  $1^3 \mapsto 3^2 \mapsto 1^4$  \_\_\_\_\_  
 This arrangement cannot be obtained using buttons 1 through 4.

6.



- This arrangement can be obtained using the sequence of buttons \_\_\_\_\_  
 This arrangement cannot be obtained using buttons 1 through 4.

7.



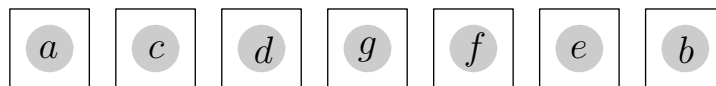
- This arrangement can be obtained using the sequence of buttons  $3 \mapsto 1$  \_\_\_\_\_  
 This arrangement cannot be obtained using buttons 1 through 4.

8.



- This arrangement can be obtained using the sequence of buttons \_\_\_\_\_  
 This arrangement cannot be obtained using buttons 1 through 4.

9.



- This arrangement can be obtained using the sequence of buttons  $4 \mapsto 3 \mapsto 2 \mapsto 1$  \_\_\_\_\_  
 This arrangement cannot be obtained using buttons 1 through 4.