

**Worksheet 10**  
**DR. M. P. M. M. M<sup>C</sup>LOUGHLIN**  
**Questions and Exercises**

Let  $U = \mathbb{R} \times \mathbb{R}$

1. Consider the permutation function  $p : \mathbb{N}_6 \rightarrow \mathbb{N}_6$  defined by:

$$\begin{pmatrix} 1 & 2 & 3 & 4 & 5 & 6 \\ 3 & 6 & 5 & 4 & 2 & 1 \end{pmatrix}$$

and the permutation function  $q : \mathbb{N}_6 \rightarrow \mathbb{N}_6$  defined by:

$$\begin{pmatrix} 1 & 2 & 3 & 4 & 5 & 6 \\ 4 & 2 & 3 & 5 & 6 & 1 \end{pmatrix}$$

- |                               |                          |
|-------------------------------|--------------------------|
| A. Find $p \circ q$           | B. Find $q \circ q$      |
| C. Find $q \circ p$           | D. Find $p \circ p$      |
| E. Find $p^{-1} \circ q$      | F. Find $q \circ q^{-1}$ |
| G. Find $q^{-1} \circ p^{-1}$ | H. Find $p^{-1} \circ p$ |

2. Consider the permutation function  $p : \mathbb{N}_6 \rightarrow \mathbb{N}_6$  defined by:

$$\begin{pmatrix} 1 & 2 & 3 & 4 & 5 & 6 \\ 3 & 6 & 5 & 4 & 2 & 1 \end{pmatrix}$$

the permutation function  $q : \mathbb{N}_6 \rightarrow \mathbb{N}_6$  defined by:

$$\begin{pmatrix} 1 & 2 & 3 & 4 & 5 & 6 \\ 4 & 2 & 3 & 5 & 6 & 1 \end{pmatrix}$$

the permutation function  $t : \mathbb{N}_6 \rightarrow \mathbb{N}_6$  defined by:

$$\begin{pmatrix} 1 & 2 & 3 & 4 & 5 & 6 \\ 1 & 2 & 4 & 3 & 6 & 5 \end{pmatrix}$$

- |                             |                             |
|-----------------------------|-----------------------------|
| A. Find $p \circ q \circ t$ | B. Find $t \circ q \circ p$ |
|-----------------------------|-----------------------------|

3. Consider the function  $k : \mathbb{N}_6 \rightarrow \mathbb{N}_6$  defined by:

$$k = \{(1, 2), (2, 3), (3, 4), (4, 5), (5, 5), (6, 5)\}$$

the function  $j : \mathbb{N}_6 \rightarrow \mathbb{N}_6$  defined by:

$$j = \{(1, 1), (2, 3), (3, 1), (4, 1), (5, 3), (6, 2)\}$$

- |  |                     |
|--|---------------------|
| A. Find $k \circ j$  | B. Find $j \circ k$ |
| C. Find $k^{-1}$   | D. Find $j^{-1}$    |
| E. Is $k^{-1}$ a well defined function? Explain.    F. Is $j^{-1}$ a well defined function? Explain. |                     |

4. Consider the relation  $d : \mathbb{N}^* \rightarrow \mathbb{N}$  defined by:

$$d = \{(x, y) : y = x + 1\}$$

Is  $d$  a well defined function? Explain.