# Exercise 3 Solutions

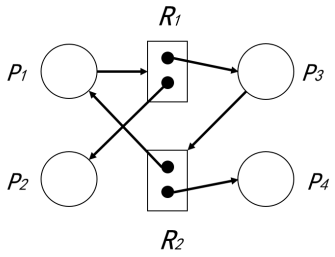
1. a. 4
   b. No
2. a.

| | Allocation | | | | Max | | | | Available | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | R1 | R2 | R3 | R4 | R1 | R2 | R3 | R4 | R1 | R2 | R3 | R4 |
| P0 | 0 | 0 | 1 | 2 | 0 | 0 | 1 | 2 | 0 | 0 | 0 | 0 |
| P1 | 2 | 0 | 0 | 0 | 2 | 7 | 5 | 0 | 0 | 7 | 5 | 0 |
| P2 | 0 | 0 | 3 | 4 | 6 | 6 | 5 | 6 | 6 | 6 | 2 | 2 |
| P3 | 2 | 3 | 5 | 4 | 4 | 3 | 5 | 6 | 2 | 0 | 0 | 2 |
| P4 | 0 | 3 | 3 | 2 | 0 | 6 | 5 | 2 | 0 | 3 | 2 | 0 |

（b）The system is in a safe state as the processes can be finished in the sequence <P0,P3,P4,P1,P2>

（c）No, it can't. Process P2 requires two R2, while there is only one free R2.

3. a. Draw the resource allocation graph.




b. P1 R1 P3 R2 P1

c. No. There is a cycle, but no deadlock. P2 and P4 have all resources for completing. P2 P4, P1, P3

4. The need matrix is as follows:

| | R1 | R2 | R3 | R4 | R5 |
|---|---|---|---|---|---|
| A | 0 | 1 | 0 | 0 | 2 |
| B | 0 | 2 | 1 | 0 | 0 |
| C | 1 | 0 | 3 | 0 | 0 |
| D | 0 | 0 | 1 | 1 | 1 |

Suppose that we are in a safe state. Process D must run first, because we have no other choice. To make process D run, the number X of R4 should be no less than 1. Since process A, B, and C do not need any more instance of resource R4, the constraint of X is X>=1.

So if and only if X>=1, the state is safe. Then the smallest value of X is 1.