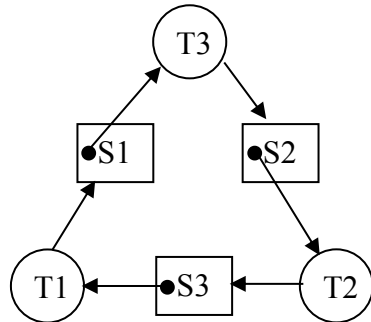


**1. Answer:**

- a) Deadlock occurs when all processes progress to their second `semwait()`.  
 b) This resource allocation graph shows the deadlock state (i.e., a circular wait).



- c) No deadlock will occur if T1 is changed.

**2. Answer:**

Consider three processes, A, B and C and three resources Q, R and S. Suppose A is waiting for Q that is held by B, B is waiting for S held by A, and C is waiting for R held by A. All three processes, A, B and C are deadlocked. However, only A and B belong to the circular chain.

**3. Answer:**

- a) Creating the 4<sup>th</sup> process and grant its initial request would result in a safe state:

Process	Claim	Allocation	C-A
1	70	45	25
2	60	40	20
3	60	15	45
4	60	25	35

Available
25

There is sufficient free memory (25 units) to guarantee the termination of either P1 or P2. After that, the remaining three processes can be completed in any order.

- b) Creating the 4<sup>th</sup> process and grant its initial request would result in an unsafe state:

Process	Claim	Allocation	C-A
1	70	45	25
2	60	40	20
3	60	15	45
4	60	35	25

Available
15

There is NO sufficient free memory (15 units) to satisfy any process.

**Self-test**

- D
- C
- B
- D
- A
- C