Mechanic Problem: Deadlock, R-A Graphs, Banker's and Detection Algorithms

A tire repair shop employs mechanics who change tires continuously. Changing a tire is executed in 7 steps. Each step requires that the mechanic possess at least one tool. The tools and number available are:

3	Crowbar/Mallet	- Used to remove/replace hubcaps and operate jack
2	Jack	- Used to lift car
3	Stand	- Used to hold car up after jacking
4	Wrench	- Used to remove lug nuts (they hold tire on)
3	Tire Tools	- Used to remove tire from rim and replace it

Here are the 7 steps, along with the tool(s) required:

Number	Step	Tool(s) Required
1	Remove Hubcap	Crowbar/Mallet
2	Raise Car	Jack & Stand & Crowbar/Mallet
3	Remove Lug Nuts	Wrench & Stand
4	Change Tire	Stand & Tire Tools & Crowbar/Mallet
5	Replace Lug Nuts	Wrench & Stand
6	Lower Car	Jack & Stand & Crowbar/Mallet
7	Replace Hubcap	Crowbar/Mallet

Note:
1. Stands are retained from step 2 thru step 6
2. Crowbar/Mallets are retained from step 6 of one car thru step 2 of the next car
3. All other items are retained for one step only

Exercises

1. a. Write a process that simulates a mechanic. Use semaphores to control access to the resources. State the initial value of each semaphore.

   b. Repeat, using a monitor to control access to resources. Don't forget the initialization code.

2. a. Draw a Resource-Allocation Graph for the following scenario:
   Mechanic #1 is in step 1.
   Mechanic #2 is waiting to begin step 2.
   Mechanic #3 is waiting to begin step 4.
   Mechanic #4 is in step 5.
   Mechanic #5 is in step 6.

   Note that a mechanic that is waiting has made a request that has not yet been granted, ***even if the requested item is available.***

   b. Is part a in a state of deadlock? Use the deadlock detection algorithm to find out. If there is no deadlock, draw an R-A graph in a state of deadlock using no more than five mechanics. Use the deadlock detection algorithm to show which mechanics are deadlocked.

   c. How many mechanics can work concurrently without deadlock being possible?

   d. Use the banker's algorithm to show whether the requests of mechanics 2 & 3 can be granted. This requires two separate executions of the safety algorithm (if the requested tools are available). Assume that in each case, the tools from the previous step have been put down and that none of the tools for the next step have been acquired.