Assuming a 32-bit system using 8KB pages, what page number is virtual address 1011 0111 1000 0110 0110 1010 0001 0000 in? (Virtual address provided in binary, spaces just to make reading easier) *Leave your answer in binary*.

1011 0111 1000 0110 011 – the first 32-13=19 bits (should be autograded with regex, check I didn't screw it up).

(all or nothing)

List an advantage and a disadvantage of using memory-mapped I/O over I/O ports.

Memory mapped IO does not use dedicated machine instructions, using only loads and stores (so high level languages can use it without inline assembly).

Memory mapped IO uses address space, ports are in a separate address space. This means less virtual addresses are available for holding code and data.

(3 points per adv/disadv) – could be variations of this, use your judgment

Imagine we have a disk with 100 cylinders and the arm is floating at track 35. There is a queue of requests for the following tracks to be accessed {20, 45, 15, 80, 85}. What is the minimum seek distance if the Elevator Algorithm (SCAN) is used?

120 – should be autograded

(all or nothing)

Using the page table below, if a page fault occurs and the policy is NRU (not recently used), what physical frame is evicted?

We're looking for a frame that is valid (V=1), unreferenced (R=0), and clean (D=0), which we have in Frame 0

You may have to grade this as I wrote page 0 in the regex. Frame 0 is right, we'll also accept page 0.

What is a process's **working set**? Use the term to explain the idea of *pre-paging.*

The working set is the set of pages a process is using "now". (4 points)

Pre-paging is guessing the initial working set to avoid the flurry of page faults that demand paging generates while discovering the working set. (4 points)

What is RAID 4 and how is it different than RAID 5?

RAID 4 uses redundancy to survive the reliability issues of having more disks (increased overall failure rate) of RAID 0, but unlike RAID 1, does not require 2*N disks for the same capacity. RAID 4 uses N+1 disks, where the one disk holds parity information. We can survive any one disk failure (but never 2).

RAID 5 is identical to RAID 4 in every way except it distributes the parity information across the disks (RAID 4 has one dedicated parity disk). This alleviates a bottleneck that can occur with the parity disk if two independent modifications are happening at the same time.

6 points for the description of RAID 4 (saying about parity, capacity, and survival after failure)

4 points for the difference from RAID 4.