1. Hardware Upgrade

1.1: 2 points

1 point for a correct answer.
1 point for adequate work - using the access time weighted by hit rate probabilities formula.

Average memory access time =

$$T_{TLB} + (1 - P_{TLBMiss}) * [T_{Cache} + P_{CacheMiss} * T_{DRAM}] +$$

$$P_{TLBMiss} * [2T_{DRAM} + (1 - P_{Fault}) * [T_{Cache} + P_{CacheMiss} * T_{DRAM}] + P_{Fault} * T_{HDD}]$$

Let Int1 = 6, Int2 = 3. Then,

$$T_{avg} = 1+(1-.01)*[1+.01*160]+.01*[2*160+(1-.00002)*[1+.01*160]+.00002*13*10^6]$$

$$T_{avg} = 9.4ns$$

1.2: 2 points

1 point for choosing A, B, and C (all three must be chosen). No points awarded in this section if this answer is wrong.
1 point for the correct memory access time calculation.

Average memory access time =

$$T_{TLB} + (1 - P_{TLBMiss}) * [T_{Cache} + P_{CacheMiss} * T_{DRAM}] +$$

$$P_{TLBMiss}*[2T_{DRAM}+(1-P_{Fault})*[T_{Cache}+P_{CacheMiss}*T_{DRAM}]+P_{Fault}*[T_{SSD}+P_{SSDMiss}*T_{HDD}]]$$

Let Int1 = 6, Int2 = 3. Then,

$$T_{avg} = 1+(1-.01)*[1+.01*160]+.01*[2*160+(1-.00001)*[1+.01*160]+.00001*[16*1000+.1*7*10^6]]$$

$$T_{avg} = 6.87ns$$

2. Raid by RAID

2.1: 1 point

1 point for a correct answer.

4000 tracks * 6000 sectors * 512 bytes * 5 disks $\approx 572.2GiB$

2.2: 2 points

1 point for accessing disks 0, 2, 3, 4, and 5.
1 point for reconstructing disk 1 by XORing bits from the other disks.

2.3: 2 points

1 point for a correct answer.

Writing to block 0 access Disk 0 and Disk 5 (for parity). So, we must eliminate any writes to blocks that access these disks.

0: Obviously writes to Disk 0.
4: Parity writes to Disk 5.
8: Ok.
21: Ok.
24: Writes to Disk 5.
26: Parity writes to Disk 0.
30: Writes to Disk 0.
38: Ok.
32: Parity writes to Disk 5.

Valid blocks: 8, 21, 38.

3. Elevator

Let Int1 = 6, Int2 = 3.
Request order: 5, 23, 9, 14, 2, 20, 4, 10, 12, 16, 30
Initial floor: 11

3.1: 2 points

2 points for a correct answer.

To calculate, sum the pairwise differences between floors.

$|11-5|+|5-23|+|23-9|+|9-14|+|14-2|+|2-20|+|20-4|+|4-10|+|10-12|+|12-16|+|16-30|$
$= 115$ floors

3.2: 2 points

2 points for a correct answer.

The next floor is the closest floor (for ties, earliest and closest floor).

$|11-10|+|10-9|+|9-12|+|12-14|+|14-16|+|16-20|+|20-23|+|23-30|+|30-5|+|5-4|+|4-2|$
$= 51$ floors

3.3: 2 points

2 points for a correct answer (We accepted LOOK or C-LOOK for this).

C-LOOK: The next floor is the closest increasing floor (restarts at lowest floor when it reaches the end).

$| 11 - 12 | + | 12 - 14 | + | 14 - 16 | + | 16 - 20 | + | 20 - 23 | + | 23 - 30 | + | 30 - 2 | + | 2 - 4 | + | 4 - 5 | + | 5 - 9 | + | 9 - 10 |$
$= 55$ floors

LOOK: The next floor is the closest increasing floor (goes reverse when it reaches the end).

$| 11 - 12 | + | 12 - 14 | + | 14 - 16 | + | 16 - 20 | + | 20 - 23 | + | 23 - 30 | + | 30 - 10 | + | 10 - 9 | + | 9 - 5 | + | 5 - 4 | + | 4 - 2 |$
$= 47$ floors