Storage Quiz
Solution

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Question 2.1

Consider the following disk setup: 6 disks, 100 GBytes capacity each.
The disks can be set up as:

a. RAID 0, across all disks
b. RAID 5, across all disks
c. RAID 10, where disks are pair-wise mirrored

Consider the following read/write performance characteristics:

1. Five times read bandwidth, reading blocks from all disks.
   Five times write bandwidth.
2. Three times read performance for each file.
   Three times write performance.
3. Six times read bandwidth, six times write performance.
4. Two times read bandwidth. Standard write performance.

Match the RAID setup with the correct performance characteristics.

Question 2.2

Consider the following disk setup: 6 disks, 100 GBytes capacity each.
The disks can be set up as:

a) RAID 0, across all disks
b) RAID 1, across all disks
c) RAID 5, across all disks
d) RAID 10, where disks are pair-wise mirrored

Which of those configurations provide enhanced read through load balancing and standard write performance?

Question 2.3

- Disk Characteristics
  - 8 disks with 16 surfaces (diameter: 3,5“)
  - 2^{16} = 65 536 tracks per surface
  - In average 2^{8} = 256 sectors per track
  - 2^{12} = 4 096 Byte per sector
  - Let us assume a block size of 2^{14} Byte (= 16 KiB)
  - 7200 rotations · min^{-1}
  - Seek time
    - Start and stop together 1ms
    - 1 ms per 1000 cylinders that have to be passed by R/W-head

- **How many sectors does one block consist of?**

  Block size / Bytes per sector = 2^{14} / 2^{12} = 4 sectors per Block

Question 2.4

- Disk Characteristics:
  - 8 disks with 16 surfaces (diameter: 3,5")
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  - 2^{12} = 4 096 Byte per sector
  - Let us assume a block size of 2^{14} Byte (= 16 KB)
  - 7200 rotations · min^{-1}
  - Seek time
    - Start and stop together 1ms
    - 1 ms per 1000 cylinders that have to be passed by R/W-head

- **What is the bit density of the outermost track (in bits per inch)?**
  - assume 10% gap on a track separating the sectors.

  - *Bits per track: 2^8 x 2^{12} Byte = 2^{20} = 1024 KiByte = 8 MiBit*
  - *Length of a track (outermost): 3,5" · $\pi \approx 11$"*
  - *ca. 10% gaps → track length 9,9" stores 8 MBits*

  → *ca. 847 000 Bits per inch*

Questions 2.5, 2.6, and 2.7

- Disk Characteristics:
  - In average 2^8 = 256 sectors per track
  - 2^{12} = 4 096 Byte per sector
  - Let us assume a block size of 2^{14} Byte (= 16 KiB)
  - 7200 rotations · min^{-1}
  - Seek time
    - Start and stop together 1ms
    - 1 ms per 1000 cylinders that have to be passed by R/W-head

- **2.9: What is the average transfer time per block?**
  - Assume a block is formed of sectors that are consecutively on a single track.

*1s / ((7200 tracks/60 sec) * 64 (blocks/track)) = 1/7680sec = ca. 130,000 ns*

- **2.10: Wthat is the average seek time?**
  - Assume that 33% of cylinders have to be passed

*0.33 * 2^{16} cylinders * 1000 (nsec / cylinders) + 1msec = 22,626,880 ns*

- **2.11: What is the average rotational delay?**

0.5 rotations / (7200 rotations / 60 sec) = 4,167,000 ns

Question 2.8

- Disk Characteristics:
  - In average 2^8 = 256 sectors per track
  - 2^{12} = 4 096 Byte per sector
  - Let us assume a block size of 2^{14} Byte (= 16 KiB)
  - 7200 rotations · min^{-1}
  - Seek time
    - Start and stop together 1ms
    - 1 ms per 1000 cylinders that have to be passed by R/W-head

- **How long does it take to read a block that is randomly accessed?**
  - Compute in ns, again round if needed, 16 KB = 16 384 Byte

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(avgTransferTime) + (avgSeekTime)   + (rotDelay) =
130,000           +  22,626,880     + 4,167,000  = 26,923,880 ns
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