Problem 1. Answer

Attribute	SSD (Solid State Drive)	HDD (Hard Disk Drive)
Magnetic Effect	An SSD is safe from any effects of magnetism.	Magnets can erase data.
Copy / Writing Speed	Generally, above 200 MB/s and up to 550 MB/s for cutting edge drives.	The range can be anywhere from 50 – 120 MB/s.
File Opening Speed	Like a memory stick, there are no moving parts to an SSD. Rather, information is stored in microchips. Because of this, SSD is much faster than HDD.	Hard disk drive uses a mechanical arm with a read/write head to move around and read information from the right location on a storage platter which makes it slower.
Power Draw	Less power draw because SSDs don't have spinning platters and instead have stable electronic chips, SSD power consumption is significantly lower and will of course lead to a much longer battery life.	HDD use more power to rotate platters, generating heat and noise.
Heat Produced	Lower power draw and no moving parts so little heat is produced.	HDD doesn't produce much heat, but it will have a measurable amount more heat than an SSD due to moving parts and higher power draw.
Vibration	No vibration as there are no moving parts.	The spinning of the platters can sometimes result in vibration.
Boot Time	Less (Around 10-13 seconds average boot up time).	More (round 30-40 seconds average boot up time).
Defragmentation	SSD drive performance is not impacted by fragmentation. So, defragmentation is not necessary.	The performance of HDD drives worsens due to fragmentation; therefore, they need to be periodically defragmented.
Weight	SSD are lighter than HDD drives because they don't have the rotating disks, spindle and motor.	HDD are heavier than SSD drives.
Cost	Expensive	very cheap (buying a 4TB model)

Capacity	Smaller (4TB max for desktops)	Larger (10TB max for desktops)

Problem 2.1

2.a. What is the capacity of the disk?

Sol: rpm= 10,000, no. of tracks=no of cylinders= 10,000, no. of surface= 10

No. of sectors=1000 with 512 bytes

Bytes/Track = (512*1000)/10,000 bytes= 51.2 bytes

Total capacity= (total no. of cylinders) * (Bytes/cylinder) = 10,000*51.2 = **512000 bytes**

2.b. If all tracks hold the same number of sectors, what is the minimum and maximum density of bits in the sectors of a track?

Sol: Length of outermost track = $2\pi * r1 = 2\pi*(3.5/2) = 3.5\ \pi = 11$ inches

20% of each track is used for gaps.

So useful track length = 80% of 11 inches = 8.8 inches

Outermost track will have the minimum density which will be (1000 *512)/8.8 bytes/inch

minimum density = 512000/8.8 bytes/inch

= (512000*8)/8.8 bits/inch = 465,454.545 bits/inch

$= 465.45 * 10^3$ bits/inch

Now, Length of innermost track = $2\pi * r2 = 2\pi*(0.75) = 1.5\ \pi = 4.7$ inches

20% of each track is used for gaps.

So useful track length = 80% of 4.7 inches = 3.76 inches

Innermost track will have the maximum density which will be (1000 *512)/3.76 bytes/inch

maximum density = 512000/3.76 bytes/inch

= (512000*8)/3.76 bits/inch = 1,089,361.7 bits/inch

= **$1.08 * 10^6$ bits/inch**

2.c. What is the maximum seek time?

Sol: Maximum seek time = 1+.001n milliseconds, where n= total no of tracks

= 1+ .001*10,000= 1+10 =**11 milliseconds**

2.d. What is a maximum rotational latency?

Sol: One full revolution is maximum rotational latency. Since the disk rotates at 10,000 rpm, it takes 1/10000 of a minute, or 60/10000 secs = 0.006 secs

∴ maximum rotational latency = **0.006 secs**

2.e. If a block is 16,384 bytes (i.e., 32 sectors), what is the transfer time of a block?

Sol: Gaps represent 20% of the circle and sectors the remaining 80%. There are 1000 gaps and 1000 sectors around the circle.

Since the gaps cover 360° * 0.2 = 72° of arc and sectors the remaining (360°- 72°) =288°,

∴ total degrees of arc covered by 31 gaps and 32sectors is:

= 72 x (31/1000) + 288 x (32/1000) = 2.232 + 9.216 =11.448°

∴ Transfer time = (11.448/360) *0.006 seconds

= 0.0001908 seconds = **0.1908 milliseconds**

2.f. What is the average seek time?

Sol: The average seek time will be one third of maximum seek time.

∴ Average seek time = (1/3) * maximum seek time

= (1/3) * (1+.001n)) milliseconds, where n= total no of tracks

= (1/3) * (1+0.001*10,000)

= (0.3333* 11) milliseconds

= **3.666 milliseconds**

2.g. **What is the average rotational latency?**

Sol: Time taken for 1 rotation = 60/10000 = 0.006 sec = 6 milliseconds

Average rotational latency = 1/2 * revolution = (1/2) * 6 = **3 milliseconds**

Problem 3.2

3.a. What is the capacity of a track in bytes? What is the capacity of each surface? What is the capacity of the disk?

Sol: bytes/track = (bytes/sector) * (sector / track) = 512 * 50 = 25,600 bytes

bytes/surface = (bytes/track) * (track / surface) = 25600* 2000 = 51200000 bytes

Capacity of disk = bytes/disk = (bytes/surface) * (surface/disk)

= 51200000 * 2* 5 = 512,000,000 bytes **= 512 Megabytes**

3.b. How many cylinders does the disk have?

Sol: No. of cylinder = No. of tracks = **2000**

3.c. Give examples of valid block sizes. Is 256 bytes a valid block size? 2048? 51200?

Sol: Block size should be multiple of sector size but not greater than the track size.

Here, the sector size is 512, So all the multiples of 512 will be valid block size.

Examples of valid block size: 512 * 2 = 1024, 512 * 3 = 1536, 512*5 = 2560

No, **256** is not a valid block size since it not multiple of 512.

2048 is a valid block size (because of multiple of 512) however, **51200** is not a valid block size since it is exceeding the track size (track size = 512 * 50=25,600).

3.d. If the disk platters rotate at 5400 rpm, what is the maximum rotational delay?

Sol: 5400 revolution takes 60 secs

∴ 1 revolution takes 60/5400 sec = 0.0111 sec

So, maximum rotational delay = Time for taking one revolution= **0.0111 sec**

3.e. If one track of data can be transferred per revolution, what is the transfer rate?

Sol: Transfer time = block size / transfer rate

∴ Transfer rate = block size /transfer time = 25000/ (60/5400) =2250000 byte/sec =**2250 Kbyte/sec**