MAGNETIC DISKS DELIVERABLE

EXERCISE 1 A file takes 3,145,728 bytes. Give its size using both decimal and binary prefixes (kB, MB, KiB and MiB)

3,145,728B / 10^3 = **3,145.728 kB**

3,145,728B / 10^6 = **3.145728 MB**

3,145,728B / 2^{10} = **3072 KiB**

3,145,728B / 2^{20} = **3 MiB**

EXERCISE 2 A given hard disk has 8 sides (in four platters) and a linear track density of 18,000 tpi. The innermost diameter is 0.5" and the outermost diameter is 3.5".

1. **What is the useful surface in the disk? Give the result in square inches (*in^2*).**

AUXILIAR COMPUTATIONS

Inner radius = 0.5"/2 = 0,25"

Outer radius = 3.5"/2 = 1,75"

Area of the circle delimited by the outermost track:

AC = π * 1.75in^2 = 9.6211in^2

Area of the circle delimited by the innermost track:

Ac = π * 0.25in^2 = 0,1963in^2

Useful area of the surface of one plate:

AC - Ac = 9.6211in^2 - 0,1963in^2 = 9.4248 in^2

*Useful surface of the disk = Useful area of the surface of one side * Number of sides =*
*= 9.4248in^2 * 8 =* ***75.3984 in^2***

2. How many cylinders and tracks does the disk contain?

AUXILIAR COMPUTATIONS

Inner radius(computed in 2.1) = 0,25”

Outer radius (computed in 2.1) = 1,75”

Useful line lenght= 1.75” - 0.25” = 1.5”

Linear density of disk = 18,000tpi

Cylinders = Useful line length * linear density of disk

*Cylinders = 1.5” * 18,000tpi =* ***27,000 cylinders.***

Tracks = Cylinders * number of sides of the disk

*Tracks = 27,000 * 8 =* ***216,000 tracks***

EXERCISE 3 Calculate the capacity of the disk of exercise 2 assuming CAV format with 800 sectors/track and a sector size of 512 bytes. What is the areal density of the disk? Give it in kbit/in^2 and Mbit/in^2.

COMPUTING CAPACITY (CAV)

Capacity(CAV) = Heads * Cylinders * Sectors * Sector_Capacity

*Capacity(CAV) disk_ex2 = 8 * 27,000 * 800 * 512 * 8 =* ***707,788,800Kbits = =707,788.8Mbits***

COMPUTING AREAL DENSITY:

AUXILIAR COMPUTATIONS

Area of a side of a plate of the disk (computed in 2) = 9.4248 in^2

Areal density of disk = Areal density of a side of a plate = Capacity of disk / Area off a side of a plate

Areal density of disk = 707,788,800Kbits/75.3984 in^2 = ***9,387,318.56 kbits/in^2 = 9,387.31 Mbits/in^2***

EXERCISE 4 Calculate the capacity of the disk described in exercise 2 assuming it receives ZCAV format with the following distribution of 512-byte sectors:

Zone	Limits	tpi	sectors/track
0	2.75" – 3.50"	18,000	800
1	2.00" – 2.75"	18,000	1450
2	1.25" – 2.00"	18,000	2150
3	0.50" – 1.25"	18,000	2800

What is the areal density of this disk? Give it both in Mbit/in^2 and Gbit/in^2.

COMPUTING CAPACITY (ZCAV):

Capacity(ZCAV)=H * C_z * $\sum S_z$ * B

*Capacity(ZCAV) disk_ex2 = 8 * (0.75" / 2* 18,000tpi) * (800 + 1450 + 2150 + 2800) * 512B*
*= 388800000 sectors * 512B/sector =* ***199,065.6MB***
*= 388800000 sectors * 512B/sector =* ***199.07GB***

COMPUTING AREAL DENSITY:

AUXILIAR COMPUTATIONS

Area of a side of a plate of the disk (computed in 2) = 9.4248 in^2

Areal density of disk = Areal density of a side of a plate = Capacity of disk / Area off a side of a plate

*Areal density of the disk = 199,065.6 * 8 / 75.3984 in^2 =* ***21,121.46Mbit/in^2***
*199.07 * 8 / 75.3984 in^2 =* ***21.12Gbit/in^2***

EXERCISE 5 Consider the disk described in exercise 4 rotates at 9,000 rpm. The average seek time is 12 ms, and the track-to-track seek time is 1 ms. Assume the average seek time within the same zone is the global average seek time divided by the number of zones, i.e., 12/4 = 3 ms. Calculate:

1. **The average access time for each zone**.

AUXILIAR COMPUTATIONS

Time of a single rotation = 60s/min / 9,000rpm = 0.006667s = 6,667ms

Average rotational latency = 6.667ms / 2 = 3.333ms

Average access time = Average seek time + Average rotational latency

Average access time for each zone = 12ms + 3.333ms = ***15.333ms***

2. The internal transfer speed in each zone.

AUXILIAR COMPUTATIONS

Time of a single rotation(computed in 5.1) = 6,667ms

Track capacity = Number of sectors * Capacity of one sector

Internal transfer speed = Track capacity / Time of a single rotation

*Internal transfer speed zone 0 = (800 sectors * 512B/sector) / 6,667ms =* ***61.437MB/s***

*Internal transfer speed zone 1 = (1450 sectors * 512B/sector) / 6,667ms =* ***111.354MB/s***

*Internal transfer speed zone 2 = (2150 sectors * 512B/sector) / 6,667ms =* ***165.112MB/s***

*Internal transfer speed zone 3 = (2800 sectors * 512B/sector) / 6,667ms =* ***215.029MB/s***

3. The average time it takes to read a 60 KB file, assuming it is stored in correlative sectors of the same track. Consider two cases: when the track is in zone 0 and when it is in zone 3.

AUXILIAR COMPUTATIONS

Time of a single rotation(computed in 5.1) = 6,667ms

Sector transfer time = Time of a single rotation / Number of sectors in a track

Sector transfer time zone 0 = 6,667ms / 800sectors/track = 8.334 μs

Sector transfer time zone 3 = 6,667ms / 2800sectors/track = 2.381 μs

Sectors needed to save 60KB file = 60KB / 512 B/sector = 117.19 sectors => 118 sectors

Transfer time(for consecutive sectors) = Sector transfer time * number of sectors

Transfer time for 118 sectors in zone 0 = 8.334 μs * 118 = 983.412 μs = 0.98ms

Transfer time for 118 sectors in zone 3 = 2.381 μs * 118 = 280.958 μs = 0.28ms

Average access time for each zone (computed in 5.1) = 15.333ms

Average read time = Average access time + Transfer time

Average time for reading 118 sectors in zone 0 = 15.333 + 0.98 = ***16.313ms***

Average time for reading 118 sectors in zone 3 = 15.333 + 0.28 = ***15.613ms***

4. The average time it takes to read a 60 KB file stored in randomly distributed sectors of cylinders located in zone 0.

AUXILIAR COMPUTATIONS

Sector transfer time zone 0(computed in 5.3) = 8.334 μs

Time of a single rotation(computed in 5.1) = 6,667ms

As now the sectors are randomly distributed inside the same zone, we need to take into account the average seek time and the sector transfer time for each one of the sectors read.

*Average time for reading 118 sectors in zone 0 = (12ms/4 + 8.334 μ) * 118 sectors =*
= ***354.98ms = 0.354s***

5. The time for reading a 100 MB file assuming it is optimally stored in zone 0.

AUXILIAR COMPUTATIONS

Sectors occupied by file = Size of file / Size of a sector

Sectors occupied by file = 10,000,000B / 512B/sector = 195,312.5 sectors
=> 195,313 sectors.

Taking into account that, every track in zone 0 has 800 sectors, the file will occupy:

Tracks occupied by file = Sectors occupied by file / Sectors per track

Tracks occupied by file = 195,313 sectors / 800 sectors/track =
= 244.14 tracks, => 245 tracks.

Moreover, we are told that the file is optimally stored, it means that, first will try to occupy contiguous sectors in the same track, if it doesn't fit, then will occupy sectors of tracks in the same cylinder, and if it doesn't fit, sectors of tracks in zone 0 in contiguous cylinders.

Cylinders occupied by file = Tracks occupied by file / Tracks per cylinder

Cylinders occupied by file = 245 tracks / 8 tracks/cylinder = 30.6 cylinders
=> 31 cylinders.

Being aware of the previous explanation, the seek time, will only be taken into account for the first search, once. Then the reading change between sides, can be neglected supposing an ideal situation, and then we'll need to add a 1ms track-to-track delay as many times as cylinders - 1 we need to read.

Track-to-track seek time = 1 ms

Average access time (computed in 5.1) = 6.333ms

Sector transfer time zone 0(computed in 5.3) = 8.334 μs

Transfer time for 800 sectors in zone 0 = 8.334 μs * 800 sectors = 6.667ms

Remainder sectors = 195,313sectors - (244tracks*800sectors/track) = 113 sectors

Transfer time for 113 sectors in zone 0 = 8.334 μs * 113 sectors = 0.942ms

Average read time for file of 100MB in zone 0 =
= Average access time +
Transfer time for 800 sectors in zone 0 * Number of complete tracks to read +
Transfer time for "remainder sectors" in zone 0 +
Track-to-track seek time * Number of complete tracks to read + 1
*Average read time for file of 100MB in zone 0 = 15.333ms + 6.667ms * 244 + 0.942ms + 1ms * (244 + 1) = 1,888.023ms =* ***1,89 s***