COMPUTER SCIENCE

Computer Organization and Architecture

Secondary Memory & IO Interface

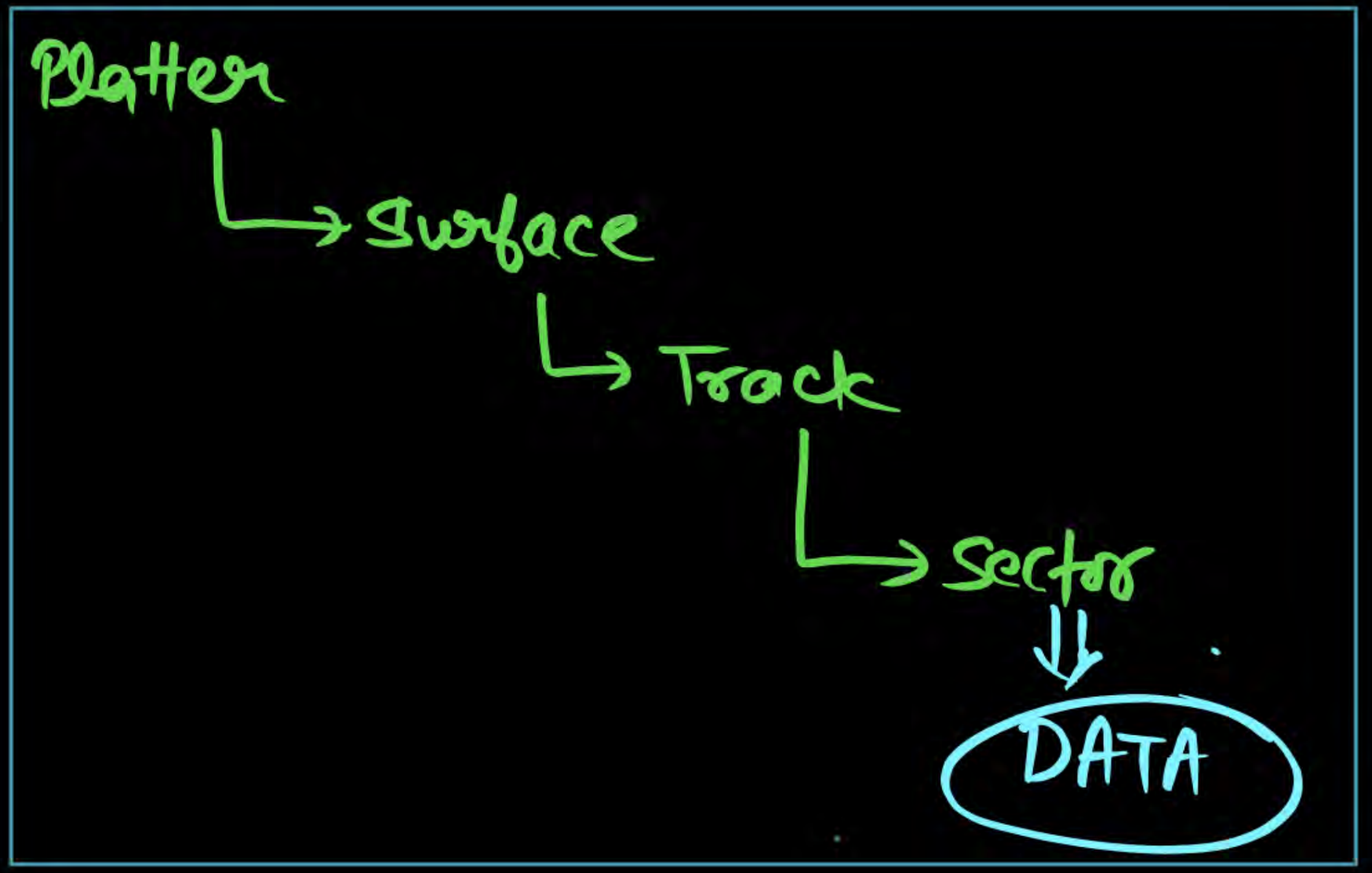
Lecture_02

Vijay Agarwal sir

01 Disk Addressing

02 IO Organization

Disk Concept



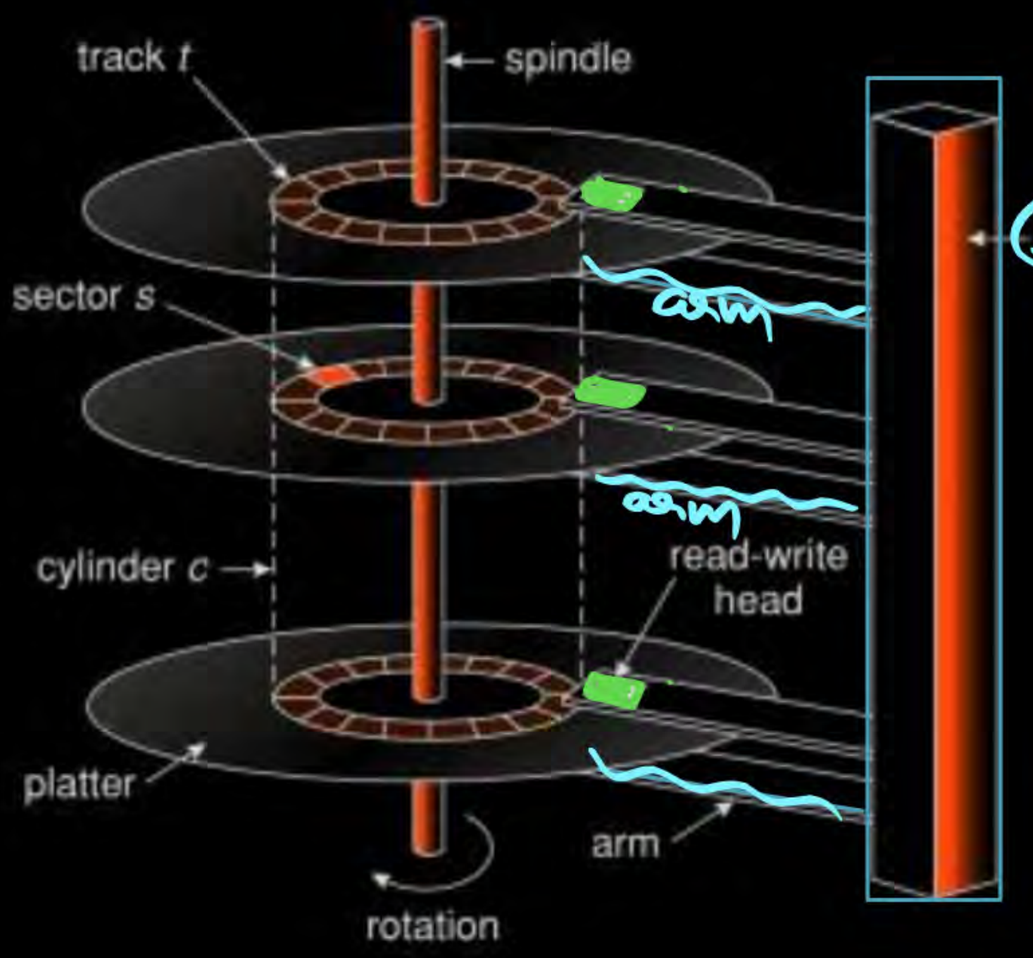
Disk

1. Disk Capacity.
2. Disk Access time & Data transfer Rate (OS)
3. Disk Addressing

<c, h, s>

- c → Cylinder
- h → Surface
- s → Sector.

Moving - Head Disk Mechanism



Each Platter has 2 Surface.

Read/write Head with each Surface to Read/write Data.

- These Read/write Head all Connected with the arm.
- All the these arm are Connected to Arm Assembly. & Rotate at the same time.

10 Platter

⇓

Q If there are 20 Surface then

Read/write Head : 20

Arm : 20

Arm Assembly : 1

Note All Read/write Head [Arm] Rotating/Moving at the same time But Only 1 R/W Head Performing Read/write Operation.

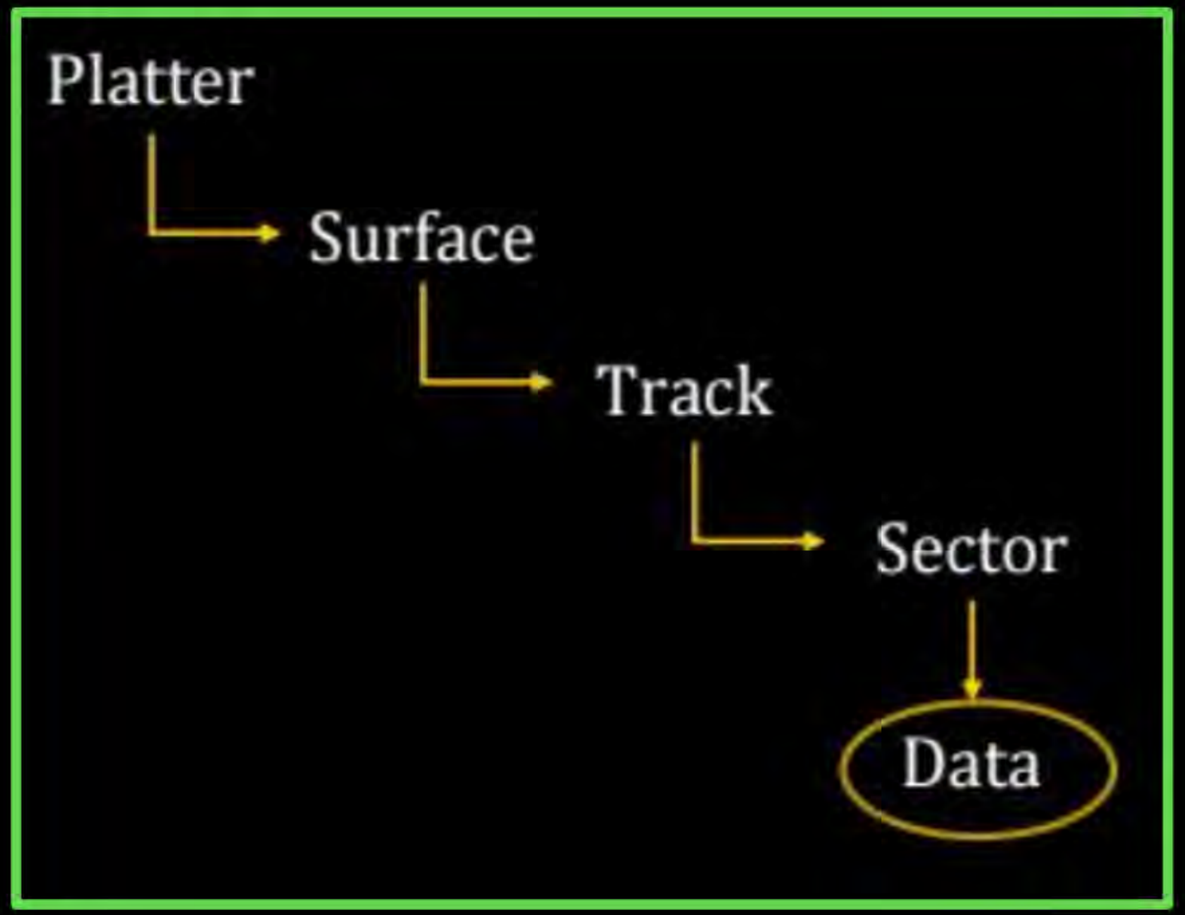
Magnetic disks provide the bulk of secondary storage for modern computer systems. Conceptually, disks are relatively simple.

Each disk platter has a flat circular shape, like a CD. Common platter diameters range from 1.8 to 3.5 inches.

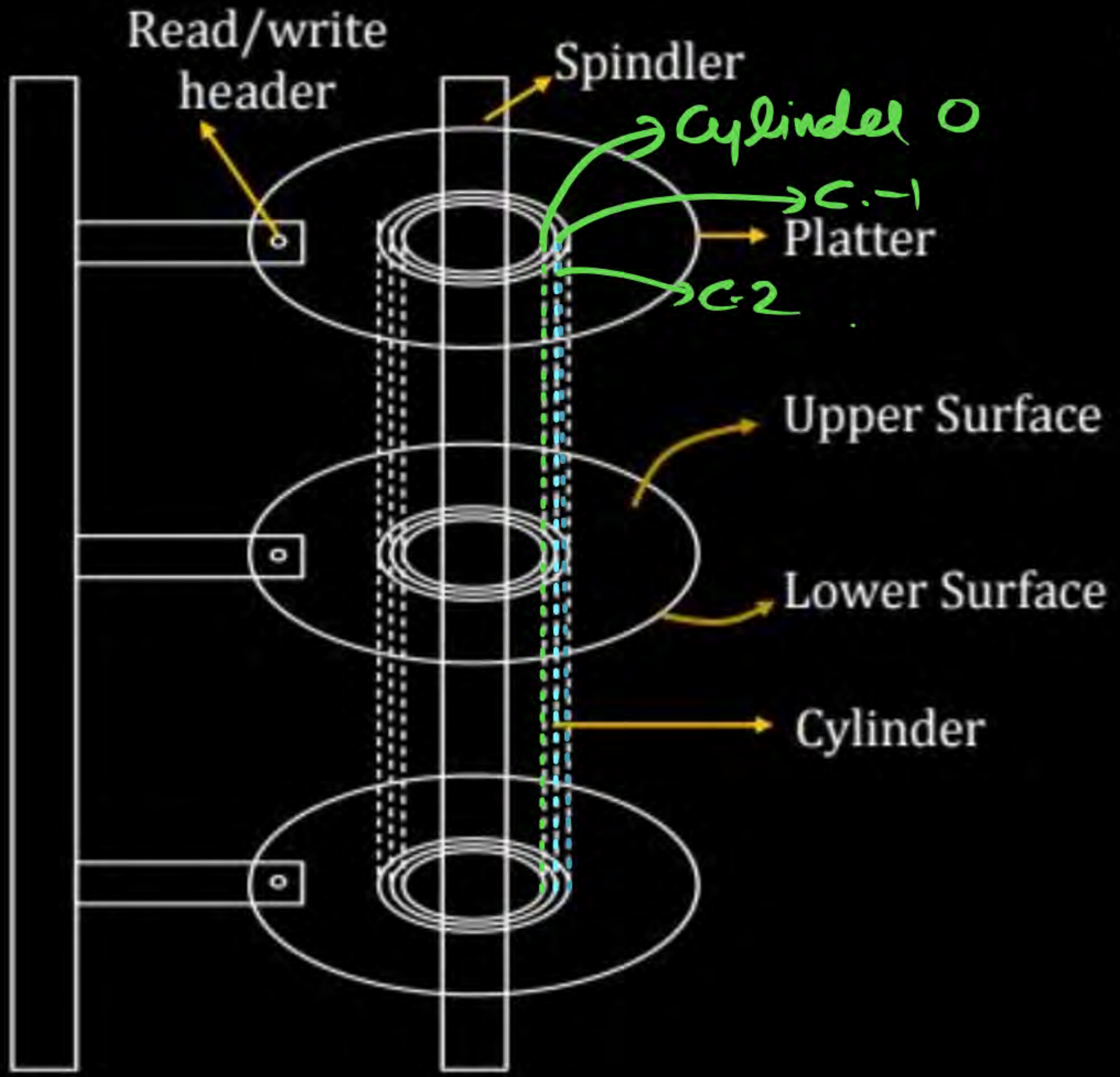
The two surfaces of a platter are covered with a magnetic heads are attached to a disk arm that moves all the heads as a unit.

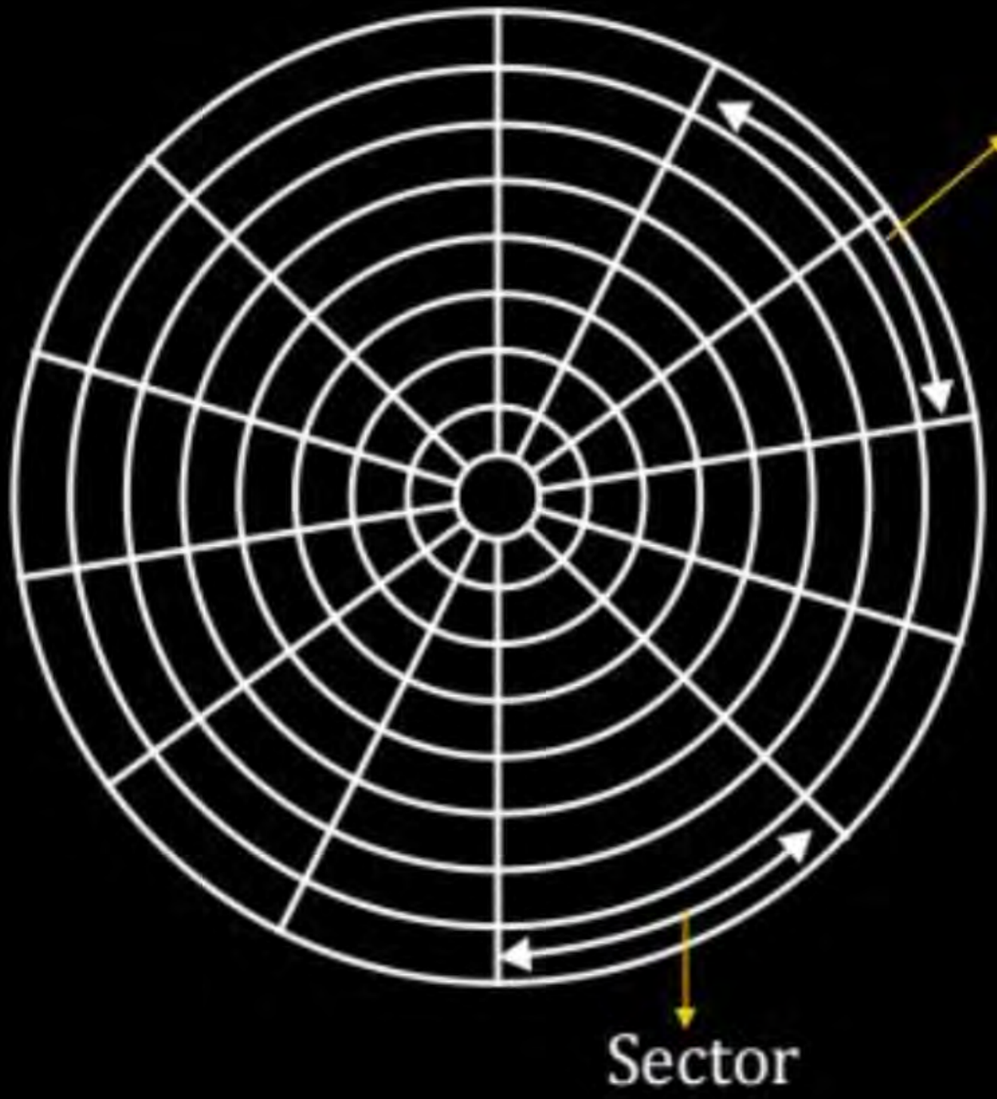
The surface of a platter logically divided into circular tracks, which are subdivided into sectors.

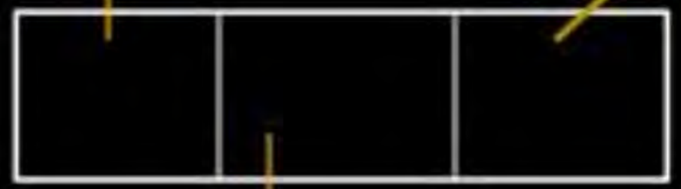
The set of tracks that are at one arm position makes up a cylinder. There may be thousand of concentric cylinders in a disk drive, and each track may contain hundreds of sectors. The storage capacity of common disk drives is measured in gigabytes.


Platter
Surface
Track
Sector
Data

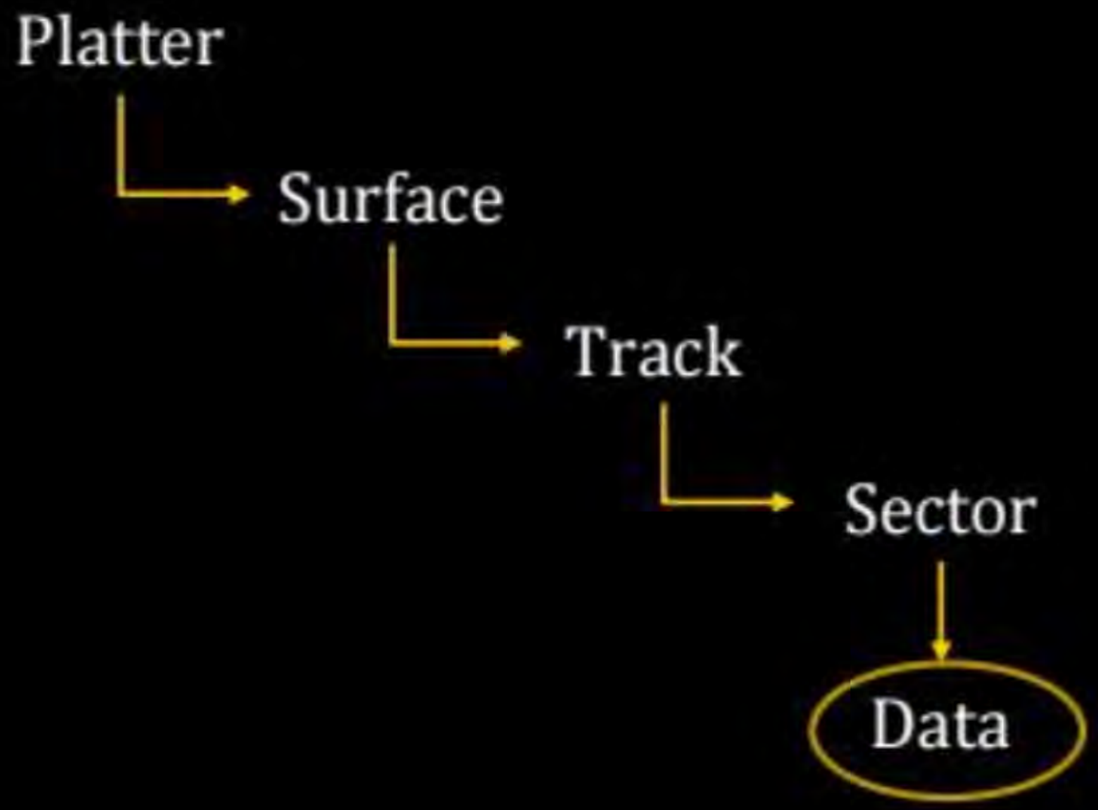
Disk - structure







Sector
Or
Disk Block


Platter
Surface
Track
Sector
Data

Q. Consider a disk which has 16 platter, each platter has two surface. Every surface has 1K Track is further Divided into 512 sector and every sector can store the 8KB Data, then calculate.

(i) What is the capacity of Disk?

(i) How many bits are required to identify any particular sector of the Disk?

Soln

16 Platter, each Platter has 2 Surface

Total Number of Surface = 32 [16×2] Surface

Tracks Per Surface = 1K track

Total # Track = 32×1k ⇒ 32k Tracks

sectors / track = 512

Total # sector = 32k × 512 Sector

Each Sector Capacity = 8KB

Disk capacity = 32K×512×8KB ⇒ $2^5 \times 2^9 \times 2^{13} \Rightarrow 2^{37} \Rightarrow$ 128GB

(ii) # bits to Identify Particular Sector $= 16 \times 2 \times 1K \times 512$

$\Rightarrow 2^4 \times 2^1 \times 2^{10} \times 2^9$

$\Rightarrow 2^{24}$

$\Downarrow$

24 bit Ans

Solution (i) 1 platter - 2 surface

16 platter - 16 × 2 i.e. 32 surface

1 surface - 1K Track

32 surface - 32 × 1K track ⇒ 32K Track

1 track - 512 sector

32k Track ⇒ 32K × 512 sector

Each sector capacity ⇒ 2KB

Total Disk capacity = 32k × 512 × 8KB

$= 2^5 \times 2^{10} \times 2^9 \times 2^{13} \Rightarrow 2^{37}$ B

Disk capacity = 128 GB Ans

(ii) #bits required to represent sector in a disk

$= 16 \times 2 \times 1k \times 512$

$= 2^4 \times 2^1 \times 2^{10} \times 2^9 \Rightarrow 2^{24}$ = 24 bits Ans

Q. Consider a disk pack with 16 surfaces. 128 tracks per surface and 256 sectors per track. 512 bytes of data are stored in a bit serial manner in a sector. The capacity of the disk pack and the number of bits required to specify a particular sector in the disk are respectively

(a) 256 Mbyte, 19 bits
(b) 265 Mbyte, 28 bits
(c) 512 Mbytes, 20 bits
(d) 64 Gbyte, 28 bits

Ans (A)

[GATE - 2007]

Disk Capacity = $16 \times 128 \times 256 \times 512$ Byte

$\Rightarrow 2^4 \times 2^7 \times 2^8 \times 2^9$ Byte

$\Rightarrow 2^{28}$ Byte

$\Rightarrow 256$ MByte Ans

(ii) # bits Required to Identify Particular Sector

$= 16 \times 128 \times 256$

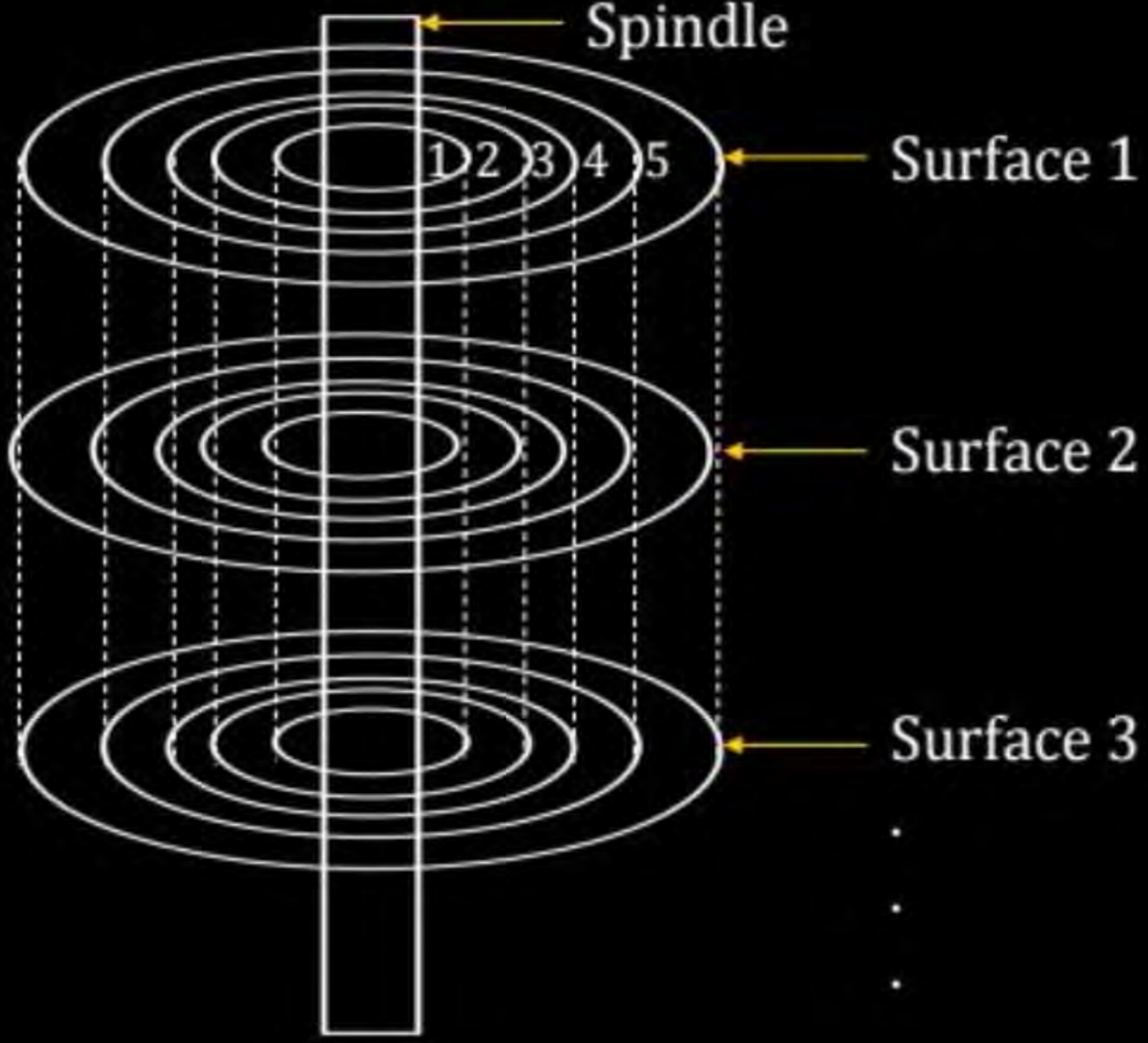
$\Rightarrow 2^4 \times 2^7 \times 2^8$

$= 2^{19}$

$\Downarrow$

19 bit

Same track number in all the surface will form a cylinder.



cylinder in the disk = # track, in the surface

Track capacity = # sector tracks * # Bytes / sector

Cylinder capacity = # surface in the disk * track capacity

Disk capacity = # cylinder in the disk * cylinder capacity

To access the data from the hard disk different adjustments are required in the hard disk so, the associative adjust latencies are -

(1) Seek time

(2) Rotational time

(3) transfer time

Time/Latency in Disk.

1. Seek Time [S.T]
2. Rotational latency (R.L)
3. Data transfer time (D.T.T)

Overhead (if Any given)

Data transfer Rate

$$R.L = \frac{1}{2} \times \text{Rotation time}$$

Disk Access time [D.A.T] = S.T + R.L + D.T.T + Overhead (if Any)

Disk I/O operation

- → Seek time
- → Rotational Latency
- → Transfer time
- → Transfer rate

- → The read / write header can never be outside the track it will be pointing to any particular track of the surface.
- → read / write header will be move in forward & backward direction & disk in one direction (either clockwise or anti-clockwise)

1) **Seek time:** The amount of time taken to move the read / write header from its current position to the desired track is called as seek time.
2) **Rotating Latency:** The amount of time taken to rotate the track when the read / write header comes to exact position (sector)

The Rotation Latency is considered as $= \frac{1}{2}$ Rotation time

3) **Transfer time:** The amount of time taken to transfer the required data.
4) **Transfer rate:** The number of bytes found for unique line is called as transfer rate of disk.

Rotational latency = $\frac{1}{2}$ x 1 Rotation time

Eg: 600 RPM [600 Rotation Per Minutes [60 sec].

1 Rotation = $\frac{60}{600}$ = $\frac{1}{10}$ sec x $\frac{1000}{1000}$ ⇒ 100×10^{-3} sec = 100msec

1 Rotation time = $\frac{1}{10}$ sec (OR) 100msec.

Avg Rotational latency = $\frac{1}{2}$ x 100 = 50msec

(or) $\frac{1}{2} \times \frac{1}{10} = \frac{1}{20}$ sec x $\frac{1000}{1000}$ = 50×10^{-3} = 50msec

Assume

Assume

360 RPM

$1\ \text{Rotation} = \frac{60}{360}$

$1\ \text{Rotation} = \frac{1}{6}\ \text{sec}$

$\#\text{SECTOR/Track} = 512$ Each sector Capacity $= 8\ \text{Byte}$

$1\ \text{Track Capacity} = 512 \times 8\ \text{Byte} \Rightarrow 2^{9} \times 2^{3}\ \text{B} = 2^{12}\ \text{B} = 4\ \text{KB}$

(Q) Assume 1 Rotation time is $\frac{1}{6}$ sec, 1 Track capacity = 4KB.
then Calculate Data transfer time for x Byte & Data transfer Rate ?

Note: In one Rotation 1 Complete Track is traversed.

(i) DATA Transfer time

4KB ——— $\frac{1}{6}$ sec

1 Byte ——— $\frac{1}{6 \times 4k}$ sec

x Byte ⟶ $\frac{x \text{ Byte}}{6 \times 4kB}$ sec

Data transfer Rate.

4KB ——— $\frac{1}{6}$ sec

$\frac{1}{6}$ sec ——— 4KB

1 sec ⟶ 4KB X 6 sec

Data transfer Rate = 24kB/sec

Disk Access time [D.A.T] = S.T + R.L + D.T.T + Overhead (if Any)

Q. Consider a disk system, which has an average seek time of 30 ns and rotational rate of the disk is 360 RPM. Each track of the disk has 512 sector, each of the size 512 Byte, then calculate.

(i) Average Seek time

(ii) Average rotational latency

(iii) data transfer time for 4 sector (continuous)?

(iv) Data transfer rate?

Sequential.

360 RPM

360 Rotation in 60 sec

$1 \text{ Rotation} = \frac{60}{360} = \frac{1}{6}$ sec

Avg S.T = 30 msec

Avg R.L = $\frac{1}{2} \times \frac{1}{6} = \frac{1}{12}$ sec

$\Rightarrow 0.083$ sec

1 Track Capacity = # Sector Per track × Each Sector Capacity $\Rightarrow 512 \times 512$ Byte $\Rightarrow 2^9 \times 2^9 B = 2^{18} B$

$= 256$ KB

1 Track Capacity = 256 KByte

Da

1 Track Capacity = 256 kB & 1 Rotation time = $\frac{1}{6}$ sec.

Data transfer Amount ⇒ (4 sector) ⇒ $4 \times 512B \Rightarrow 2^2 \times 2^9 = 2^{11} = 2KB$

Data transfer time

256 kB —— $\frac{1}{6}$ sec

x kB —— $\frac{x}{6 \times 256}$ sec

2 kB ⇒ $\frac{2}{6 \times 256}$ sec $= \frac{1}{768}$ sec

640
128
768

Data transfer Rate

256 kB —— $\frac{1}{6}$ sec

$\frac{1}{6}$ sec ⟶ 256 kB

In 1 sec ⇒ 6×256 kBps

⇒ 1536 kBps Ans

(i) Seek time = 30 ns = 30×10^{-9} sec

(ii) Rotational Latency ⇒ 360 rotation = 60 second ⇒ $\frac{60}{360} = \frac{1}{6}$

$\frac{1}{2}$ rotation = $\frac{1/2 \times 60}{360} = \frac{1}{12}$ sec

R.L = 0.083 sec.

(iii) Transfer time ⇒ In one rotation time, we can read the total size of the track & to read the required data how much time is required?

1RT = we can read total size of data

? = To read required data.

Rotation time = 1/6 second

Total size of 1 track = $2^9.2^9$ B ⇒ $2^8.2^{10}$ B = 256 KB

Required data = 4 sector

= $2^2.2^9$ B ⇒ $2^1.2^{10}$ B = 2KB

1 Track

256 KB → 1/6 sec

1B = 256 KB → 1/6 second

2 KB → $\frac{1/6 \times 2KB}{256KB}$ = 0.0013 sec

(iv) Data transfer rate

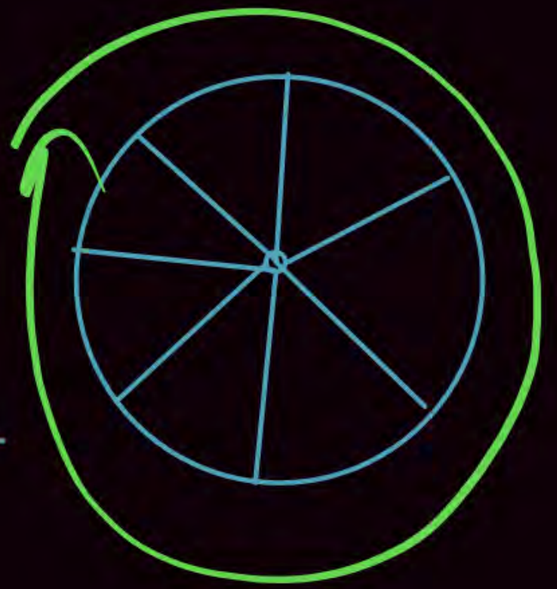
In one rotation time → we can transfer total size of the track.

In one sec → how much data we will transfer

$\frac{1}{6}$ sec → 256 KB

1 second → $\frac{256KB \times sec \times 6}{sec}$ = 1536KBPS Ans

GATE-QUESTIONS



Disk Access time = S.T + R.L + D.T.T + Overhead (if Any)
[D.A.T]

① Sequential Access: x Byte ⇒ D.T.T ⇒ x * D.T.T

D.A.T = [S.T + R.L + (x * D.T.T)]

② Random Access: x × (S.T + R.L + D.T.T)

100 Library x × (1 Disk Access)

MCQ

An application loads 100 libraries at start-up. Loading each library requires exactly one disk access. The seek time of the disk to a random location is given as 10 ms. Rotational speed of disk is 6000 rpm. If all 100 libraries are loaded from random locations on the disk, how long does it take to load all libraries? (The time to transfer data from the disk block once the head has been positioned at the start of the block may be neglected.)

D.T.T = Negligible.

[GATE-2011-CS: 2M]

A 0.50s

B 1.50s

C 1.25s

D 1.00s

Ans (B)

100 Library

$$1\,D.A.T = \underset{\text{Time}}{\text{Seek}} + \text{Avg R.L} + \text{D.T.T}$$
(Negligible Given in the Question)

Seek time = 10msec.

6000 RPM ⇒ 6000 Rotation in 60 Sec (1 minute)

$$1\,\text{Rotate} = \frac{60}{6000} = \frac{1}{100}\,\text{sec} = \frac{1}{100} \times \frac{1000}{1000} \Rightarrow 10\times10^{-3} \Rightarrow 10\text{msec}$$

$$\text{Avg R.L} = \frac{1}{2} \times 10\text{msec} = 5\text{msec}.$$

1 Disk Access time $= \underset{\text{S.T}}{10} + \underset{\text{Avg R.L}}{5} + \underset{\text{D.T.T Negligible}}{0} = 15\,\text{msec}.\ (15\times10^{-3}\,\text{Sec})$
for (1 Library)

for 100 Library $= 100\times15\times10^{-3}\,\text{Sec}$

$= 1.5\,\text{Sec Ans}$

NAT

Consider a disk pack with a seek time of 4 milliseconds and rotational speed of 10000 rotations per minute (RPM). It has 600 sectors per track and each sector can store 512 bytes of data. Consider a file stored in the disk. The file contains 2000 sectors. Assume that every sector access necessitates a seek, And the average rotational latency for accessing each sector is half of the time for one complete rotation. The total time (in milliseconds) needed to read the entire file is 14020 msec Ans

[GATE-2015(Set-1)-CS: 2M]

Ans (14020)

Time Required to Access 1 sector = S.T + Avg R.L + D.T.T (1 sector)

#Byte/Sector = 512B

Seek time = 4 millisecond — (1)

10000 RPM

#Sector/track = 600, each sector Capacity = 512B

10000 Rotation Per 60 sec (1 min.)

$1 \text{ Rotation} = \frac{60}{10000} \Rightarrow \frac{6}{1000} \Rightarrow 6 \times 10^{-3} \text{ sec}$

$\Rightarrow 6 \text{ msec}$

1 Rotation = 6 msec

Avg R.L = $\frac{1}{2} \times 6$ msec

Avg R.L = 3 msec — (2)

1 Track Capacity = #Sectors Per Track × Each Sector Capacity

= 600 × 512 Byte

600 × 512 Byte —(in 1 Rotation)→ 6 msec

x Byte = $\frac{6}{600 \times 512}$ msec.

512 Byte = $\frac{6 \times 512}{600 \times 512}$ msec

= 1/100 msec = 0.01 msec

1 Sector Access = S.T + Avg R.L + D.T.T

$\Rightarrow 4 + 3 + 0.01$

1 Sector Access time = 7.01 msec

for 2000 Sector $\Rightarrow$ 2000×7.01

$= 14020$ msec Ans

NAT

Consider a typical disk that rotates at 15000 rotations per minute (RPM) and has a transfer rate of 50×10^6 bytes/sec. If the average seek time of the disk is twice the average rotational delay and the controller's transfer time is 10 times the disk transfer time, the average time (in milliseconds) to read or write a 512-byte sector of the disk is 6.11 msec Ans

[GATE-2015(Set-2)-CS: 2M]

Ans (6.11)

$$\text{Avg Disk Access time} = \text{S.T} + \text{Avg R.L} + \text{D.T.T} + \text{Overhead}$$

15000 RPM, Data transfer Rate = 50×10^6 Byte/sec

15000 Rotation in 60 sec

$$1 \text{ Rotation} = \frac{60}{15000} \Rightarrow \frac{1}{250} \times \frac{1000}{1000} \Rightarrow 4 \times 10^{-3} \text{ sec}$$

4 msec

Avg R.L = $\frac{1}{2} \times 4$ msec

Avg R.L = 2 msec — (1)

Seek time = 2 * Avg R.L

$\Rightarrow 2 \times 2$

Seek time = 4 msec — (2)

Avg Disk Access time = S.T + Avg R.L + D.T.T + Overhead.

15000 RPM, Data transfer Rate = 50×10^6 Byte/sec, 512 Byte Data transfer

50×10^6 Byte ——— in 1 sec.

1 Byte $\Rightarrow \frac{1}{50 \times 10^6}$ sec

512 Byte $\Rightarrow \frac{512}{50 \times 10^6}$ sec $= 10.24 \times 10^{-6}$ Sec

D.T.T = 0.01024 msec (3) $\Rightarrow 0.01024 \times 10^{-3}$ sec

Overhead = 10 × D.T.T $\Rightarrow$ 10 × 0.01024 $\Rightarrow$ 0.1024 msec (4)

DAT = S.T + Avg R.L + D.T.T + overhead

$\Rightarrow 4 + 2 + 0.01024 + 0.1024$

$\Rightarrow$ 6.11126 msec

$\approx$ 6.11 msec Ans

Q. A certain moving arm disk storage, with one head, has following specifications.

Number of tracks/recording surface = 200

Disk rotation speed = 2400 rpm

Track storage capacity = 62,500 bits

The average latency of this device is P msec and the data transfer rate for all track in 1 surface is Q bits/sec.

Write the value of P and Q

[GATE-: 2 Marks]

Q. If the disk is rotation at 3600 rpm, determine the effective data transfer rate which is defined as the number of bytes transferred per second between disk and memory. (Given size of track = 512 bytes)

[GATE-: 2 Marks]

3600 Rotation in 60 sec.

1 Rotation = $\frac{60}{3600} = \frac{1}{60}$ sec.

DATA Transfer Rate

$\frac{1}{60}$ sec ——— 1 track ——— 512 Byte

(60)

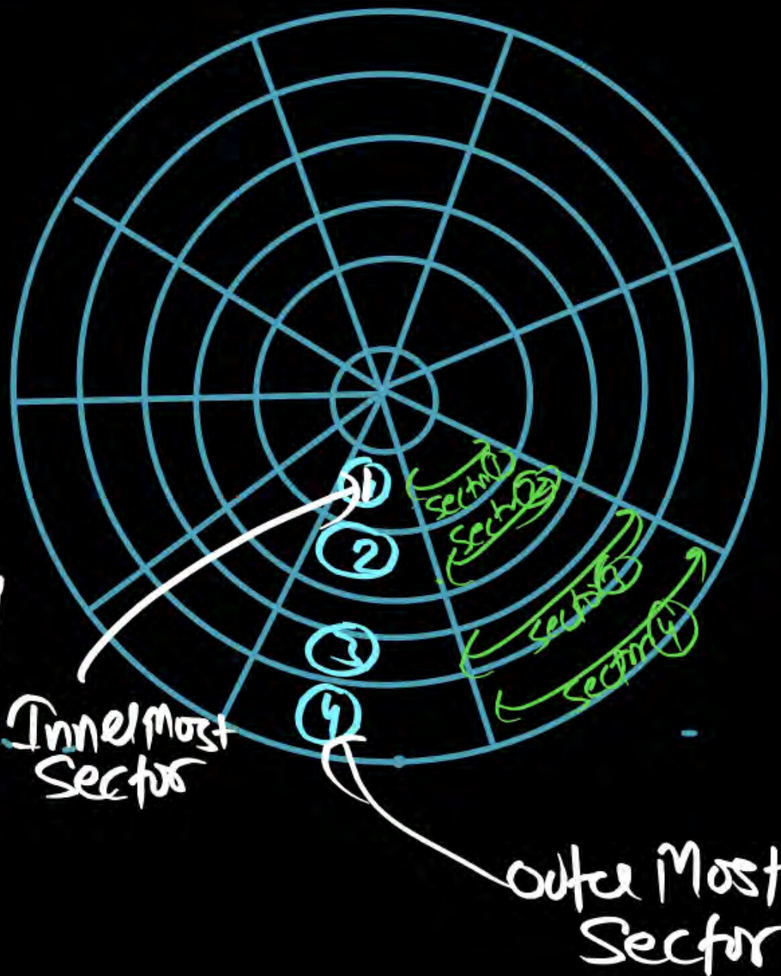
1 sec ——— 512 X 2 X 30

⇒ 1024 X 30 Byte Per Sec

⇒ 30 KBPS Ans

In a Disk Data is Stored in Sector.

In Diagram ① Sector Capacity Small
② Sector Capacity Moderate
③ Sector Capacity High
④ Sector Capacity Very High



Inner Most Sector have Smallest Capacity
Outer Most Sector have Highest Capacity.

Linear & Angular Velocity

Today times we used Fixed Sector Capacity

Fixed Sector Capacity : Each Sector has fixed Storage (Innermost & outermost Sectors have same Storage Same Size of Data)
(Storage Density is Variable)

~~(i)~~ Variable Sector Capacity : Each Sector has Variable Storage. Innermost & outermost Sector Capacity is variable
(Storage Density is Fixed)

Note Today time generally We Use Fixed Sector Capacity

Mumbai Dadar
Mumbai Dharvi
(1Acre)

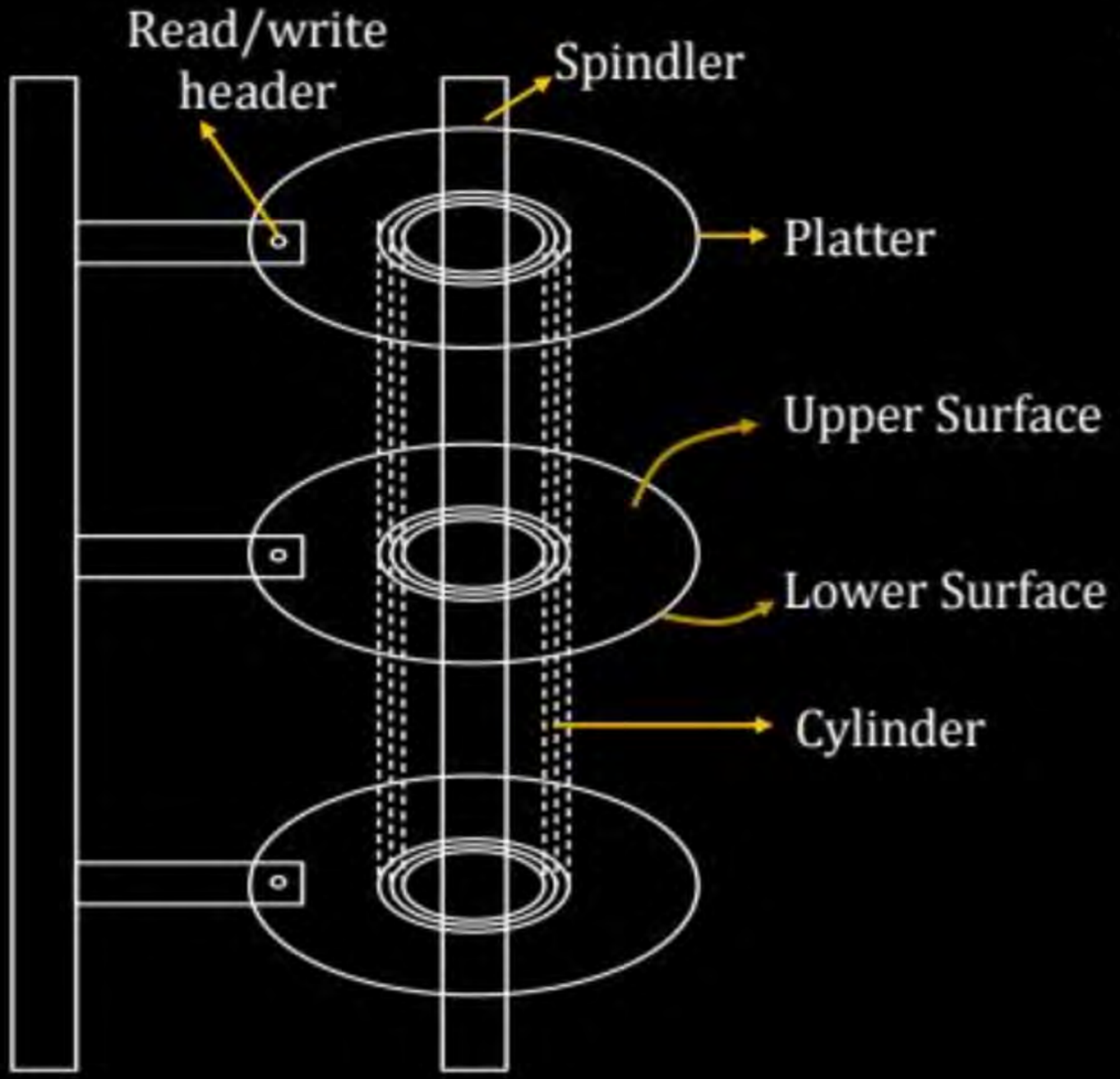
& Village 1Acre Farm House } Density Variable.

Disk

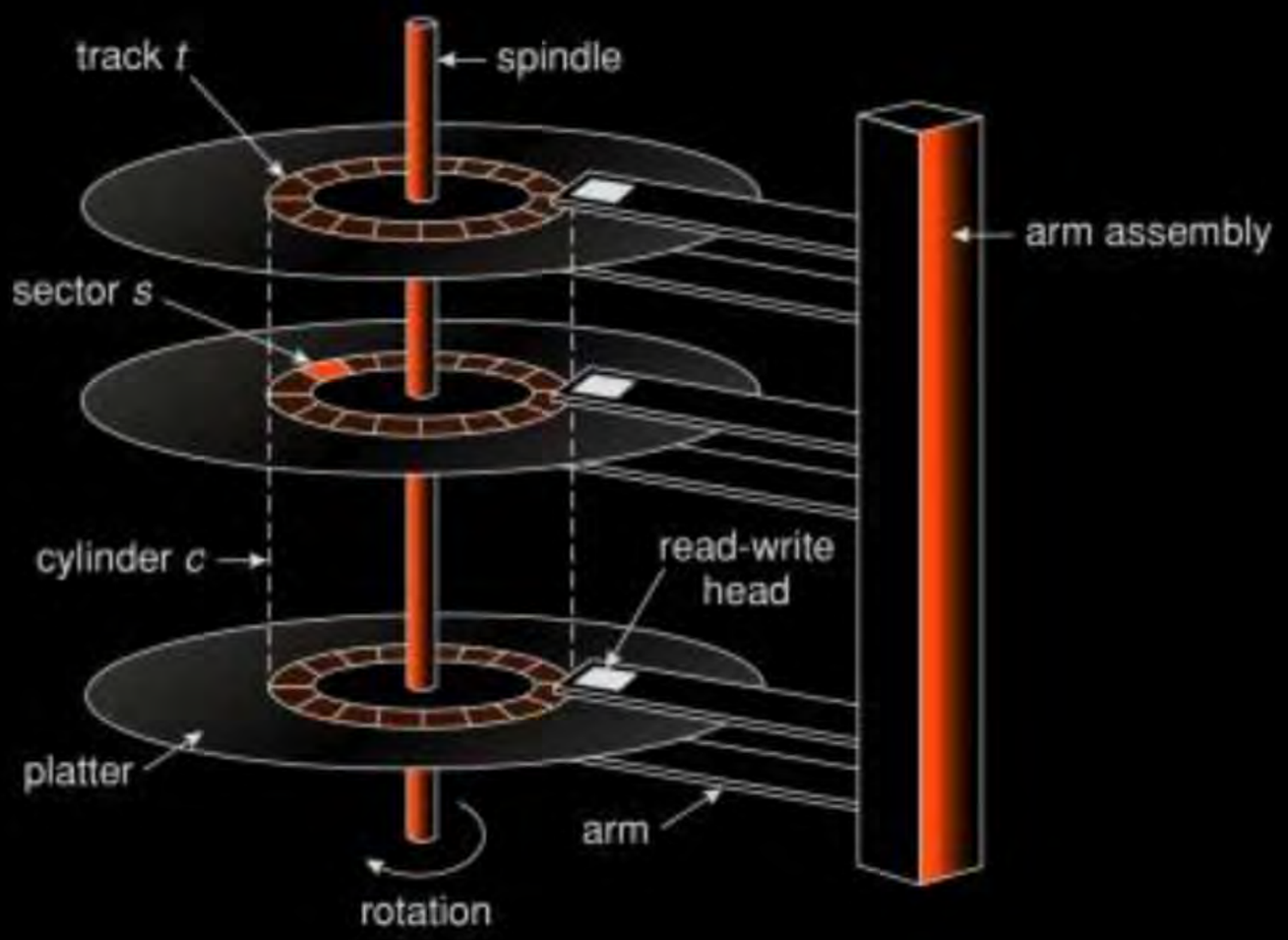
- Disk Capacity
- Disk Access time & transfer Rate
- Addressing [<c, h, s>]
  - c → (cylinder)
  - h → Surface
  - s → Sector

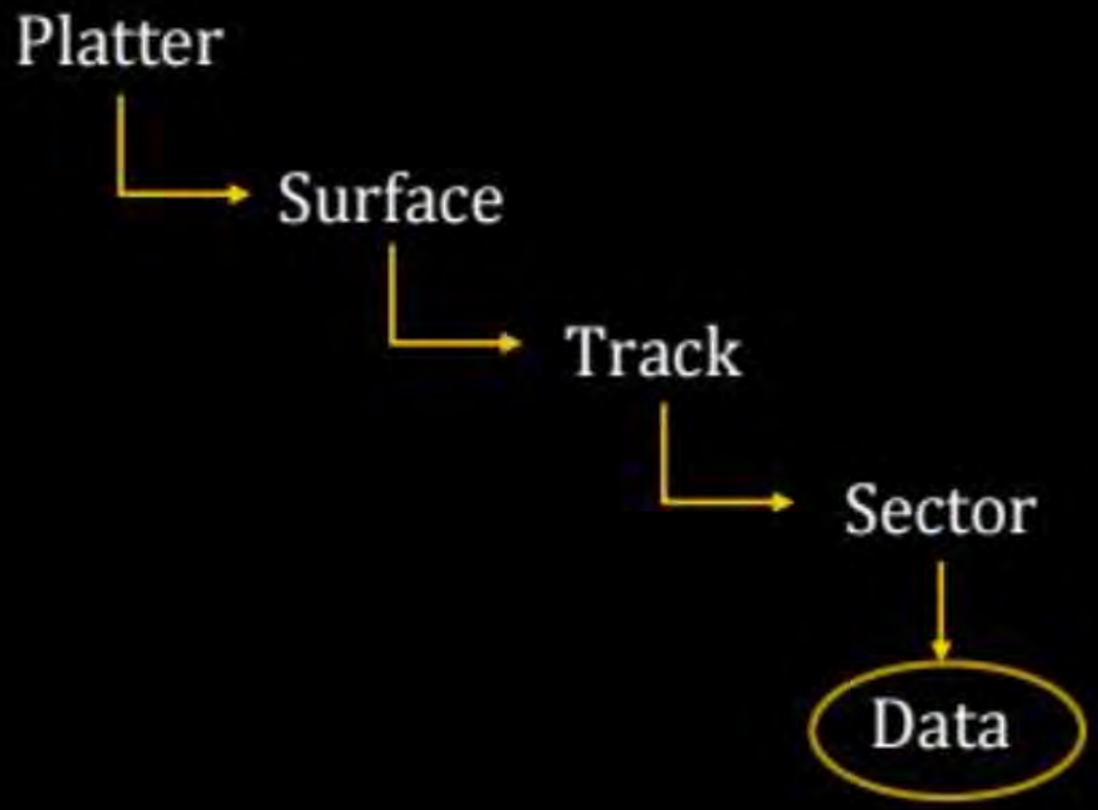
Home-Work

Disk - structure



Moving - Head Disk Mechanism

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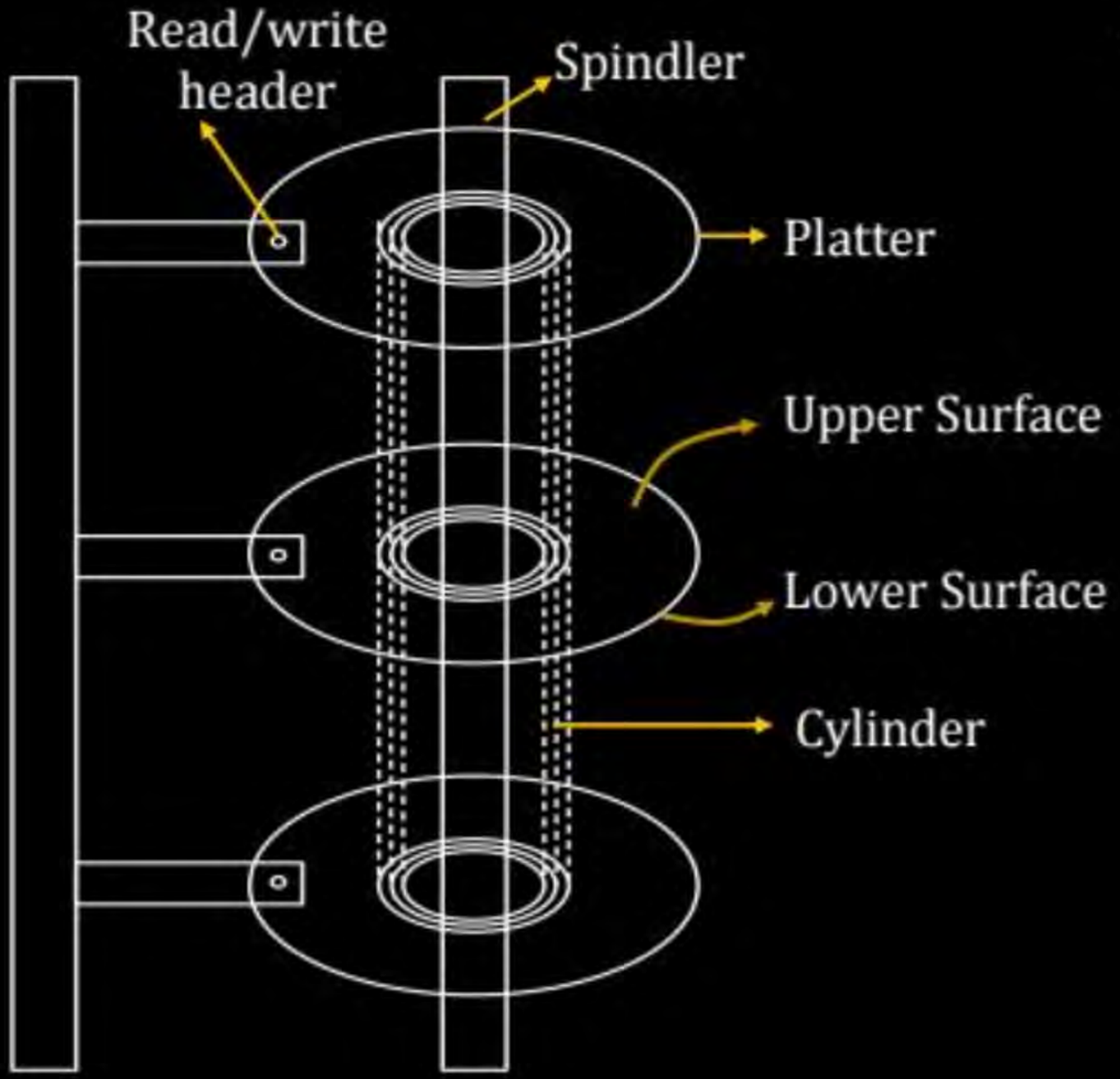
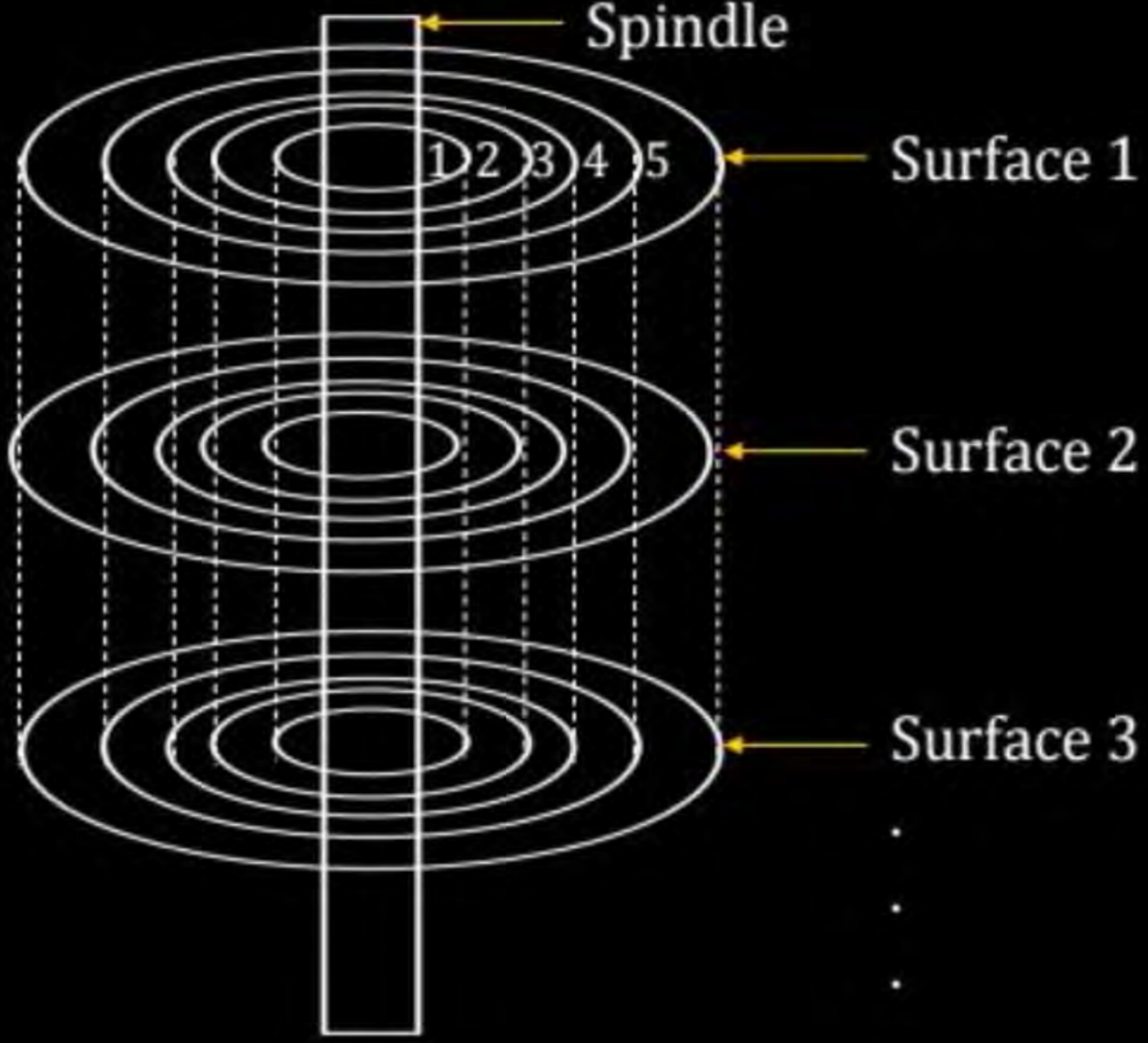
Disk - structure



Same track number in all the surface will form a cylinder.



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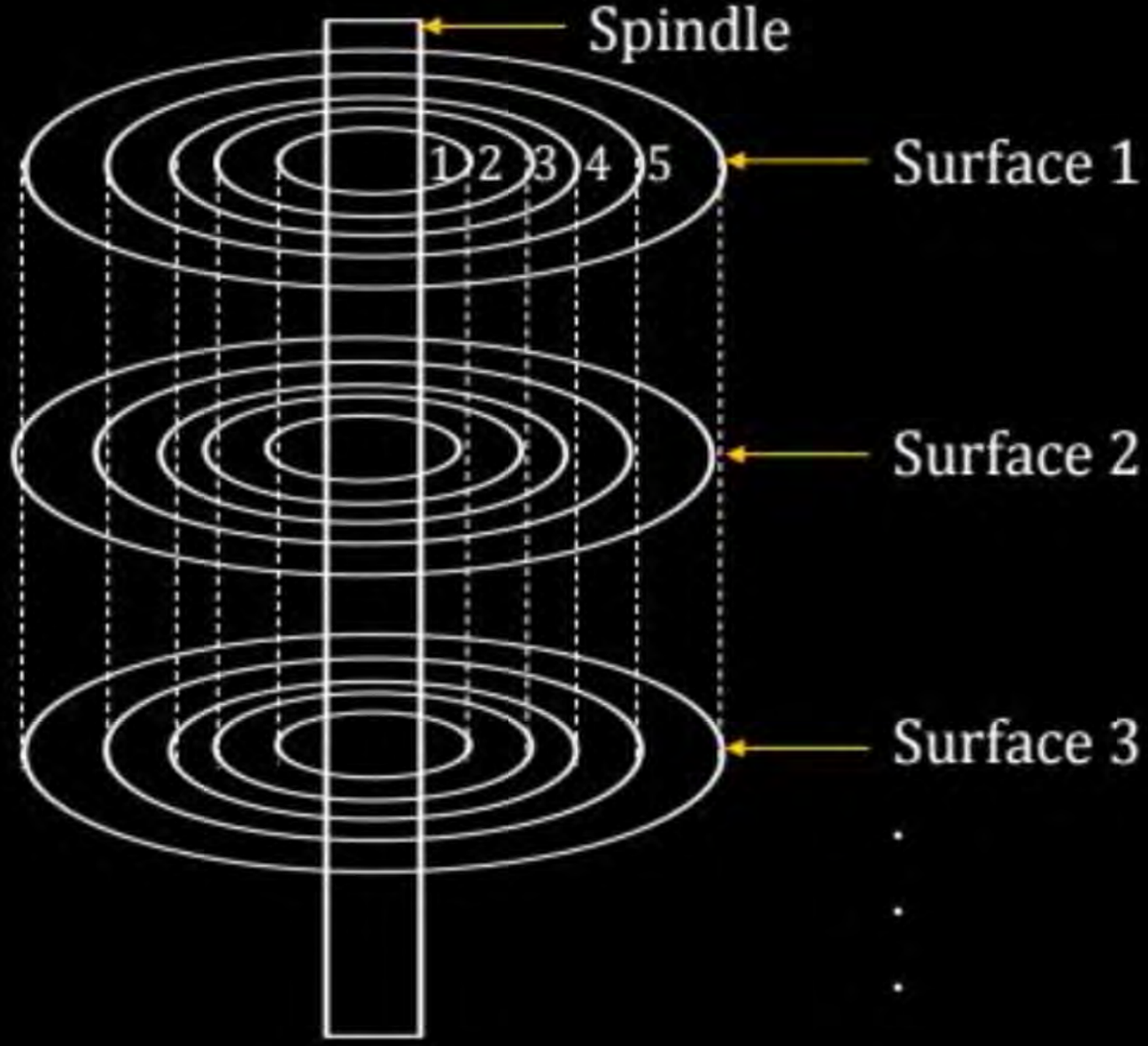


Number of Platter =2

Number of Surface =4

Number of track Per Surface =5

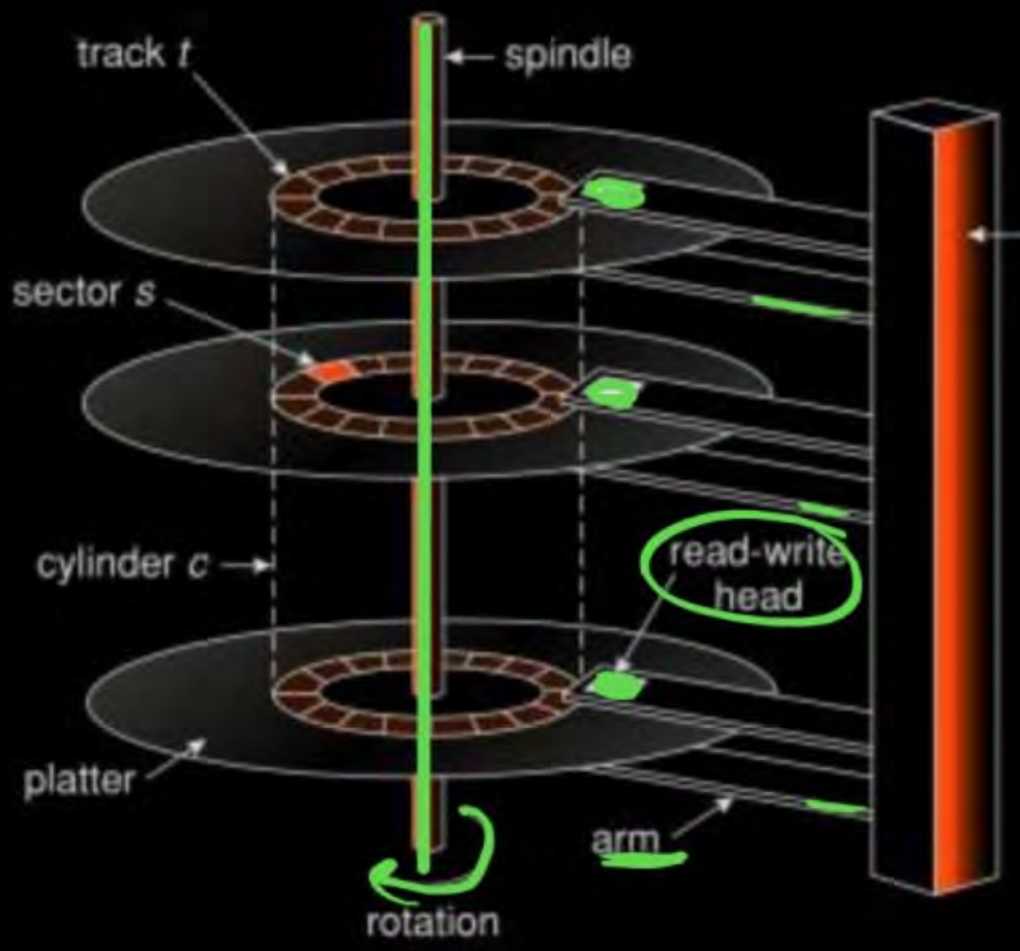
Number of Cylinder =

Number of Sector Per track =8

Number of Sector Per Cylinder=

Disk-Addressing

Moving - Head Disk Mechanism



- Each Platter has 2 Surface.
- Read/write Head for Each Surface for Reading/writing Data
- These all Read/write Head Connected with arm.
- These are Arms are Connected by all assembly & Rotate same time.

Q If there are 20 surface then

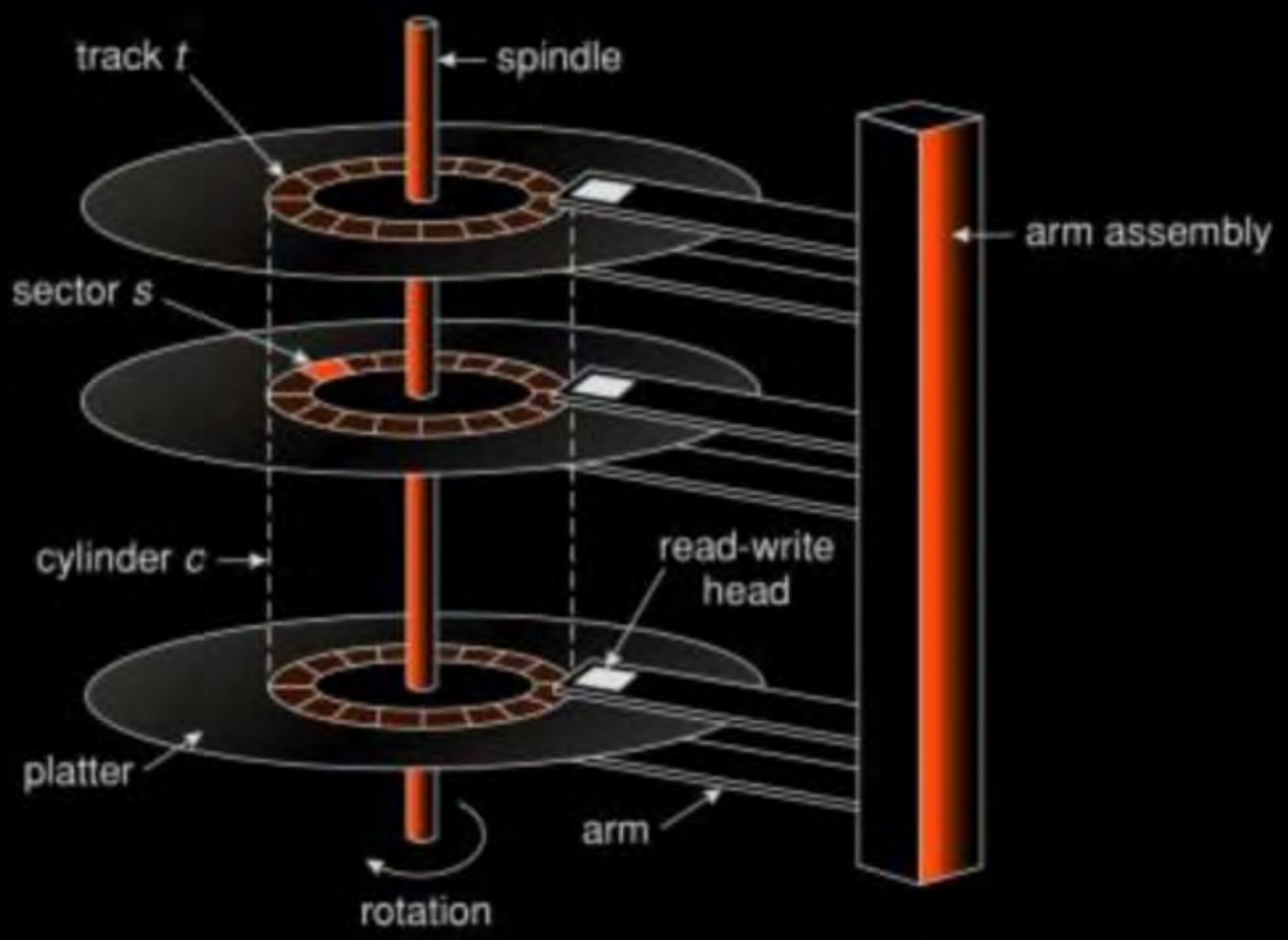
Read/write Head : 20 R/w Head

Arms : 20 Arms

Arm Assembly : 1 Arm Assembly.

All Read/write Head [Arms] Rotating/Moving at the same time.
But Only 1 R/w Head Performing write Operation.

Moving - Head Disk Mechanism



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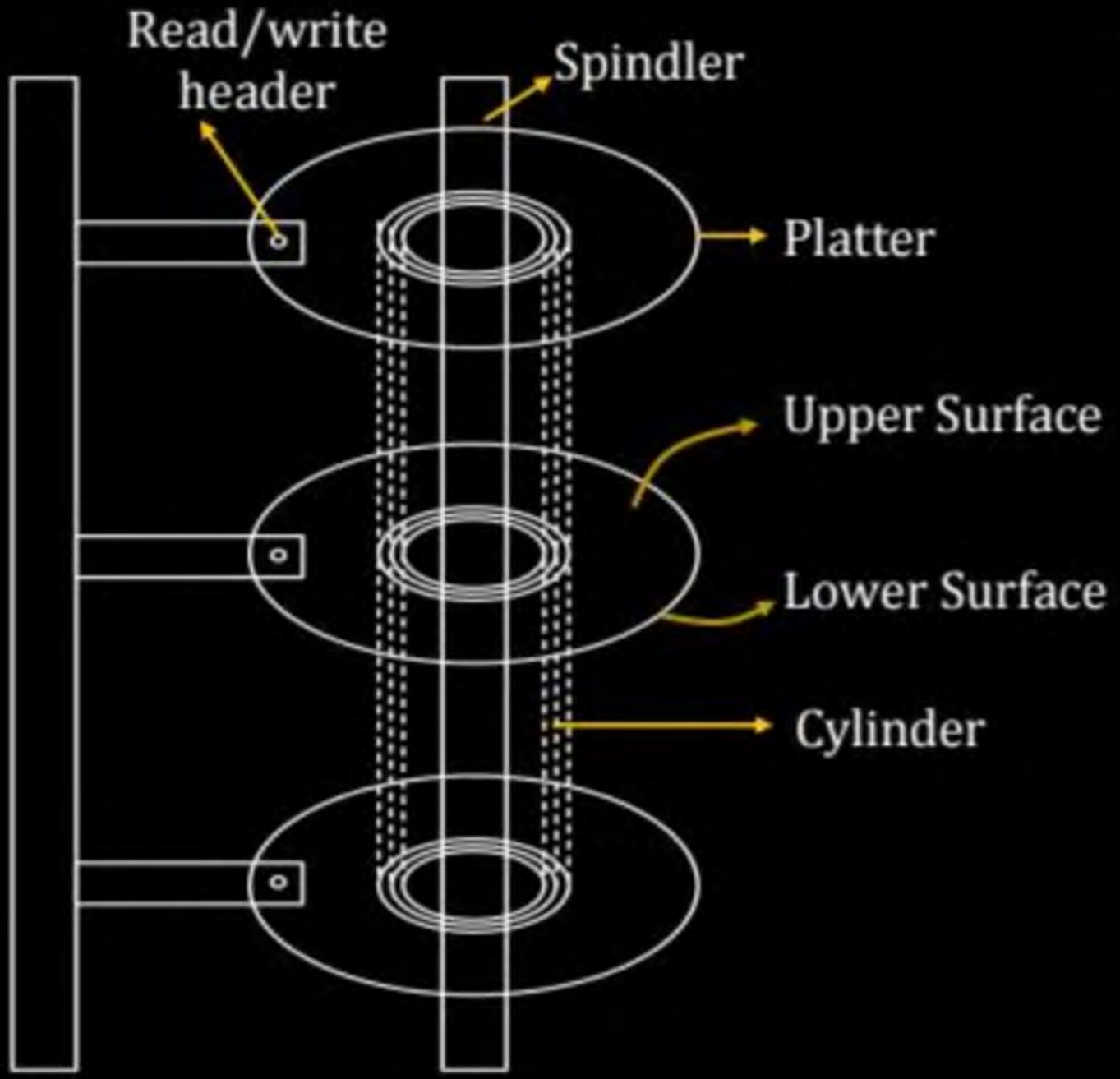
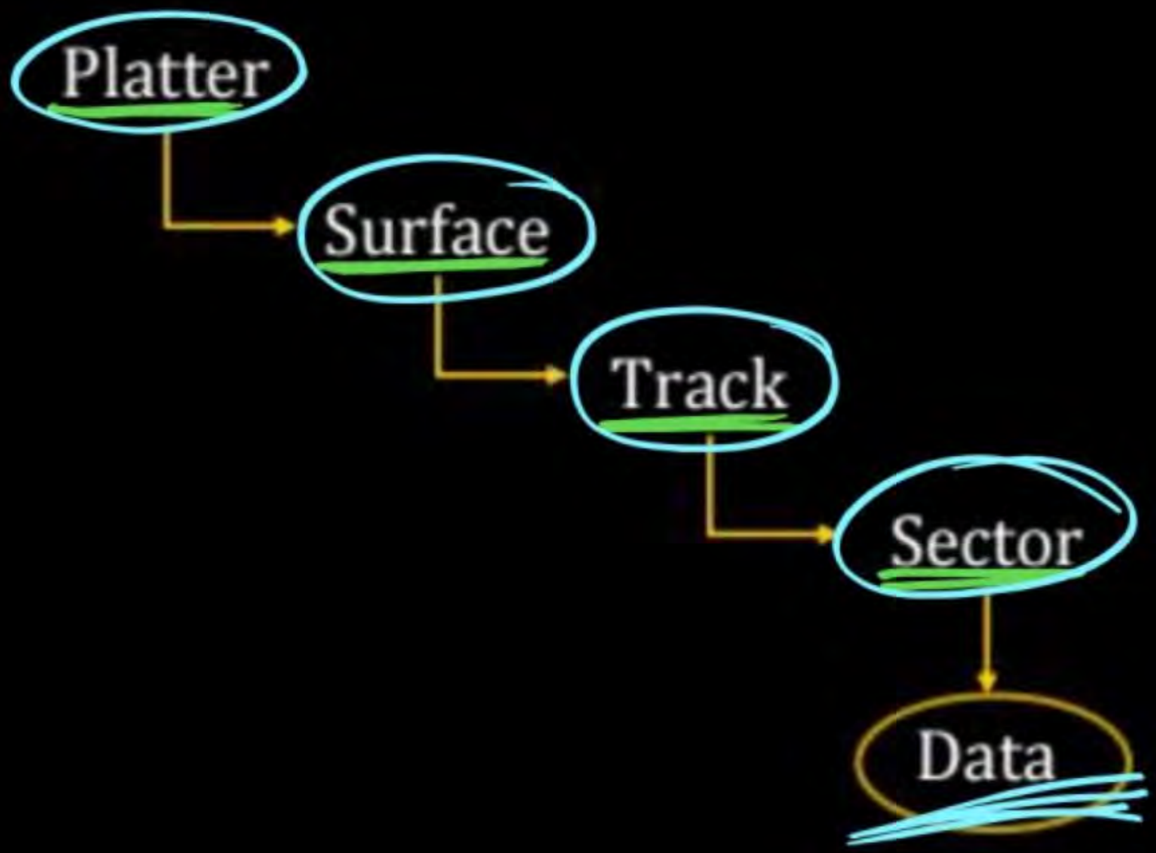
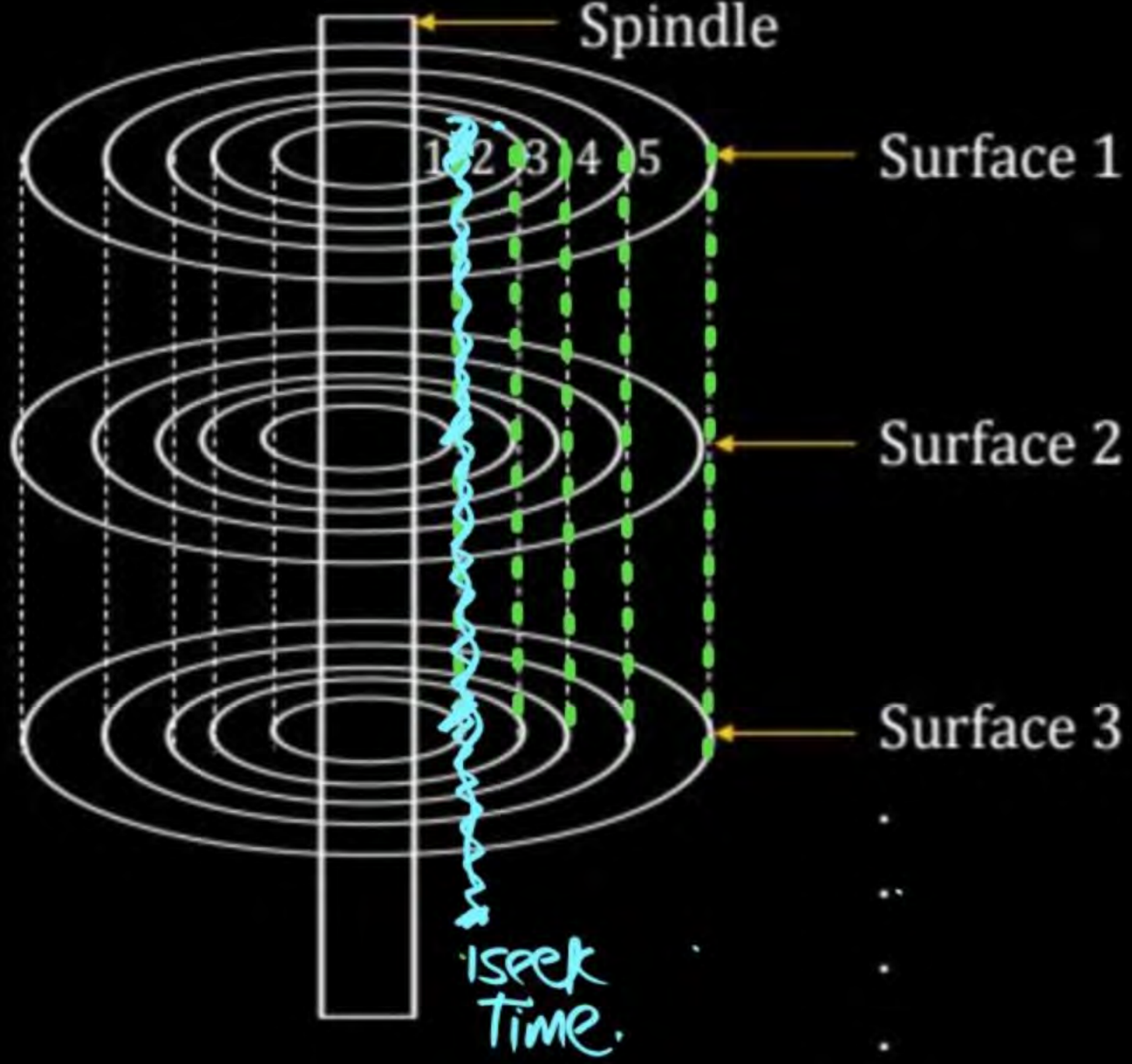
Disk - structure




Platter
Surface
Track
Sector
Data

Same track number in all the surface will form a cylinder.



Large Size File = 1 GByte

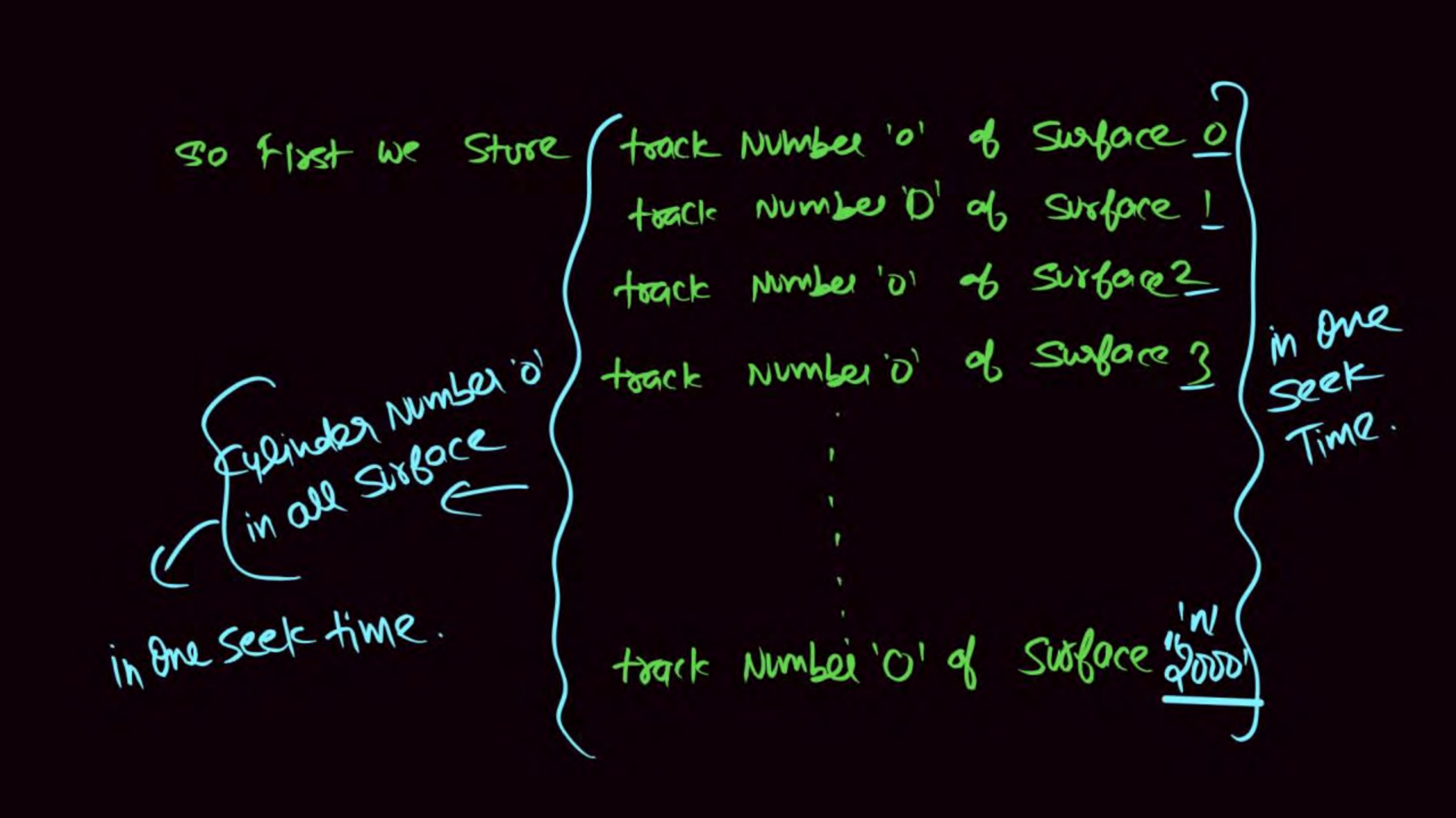
Track Size = 32MB

Q) WHy Cylinder ? Advantage of the Cylinder ?

Soln) If we have a very Large Size File (in GigaByte) & Assume track Size is 32MB,

If we Store this File then, One track Can Store 32MB So we Move to Next Track of the Same Surface So we have Suffer Seek latency every time.

Solution: So we Store in Cylinder Wise. As we know each Surface R/W Head Point to Same Address at a time.


So first we store
track Number '0' of Surface 0
track Number '1' of Surface 1
track Number '0' of Surface 2
track Number '0' of Surface 3
track Number '0' of Surface 'n'
in one seek Time.
Cylinder Number '0' in all Surface
in One seek time.

Assume

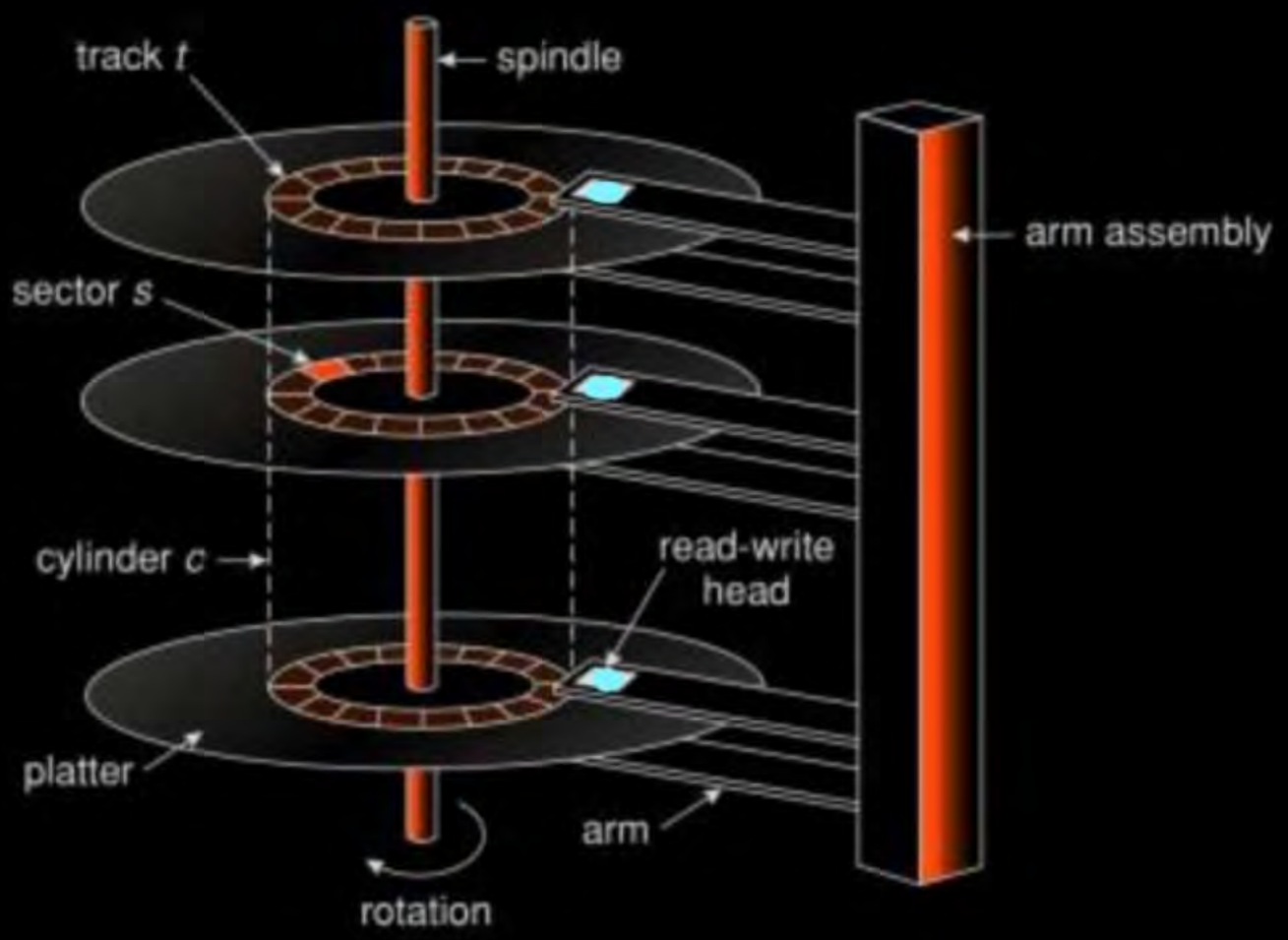
1000 Platter

2 X 1000

2000 Surface

In 2000 Track Can Store the Data in 1 Seek Time.

Moving - Head Disk Mechanism



Sector Address: <C, h. S>

(Address) Numbering

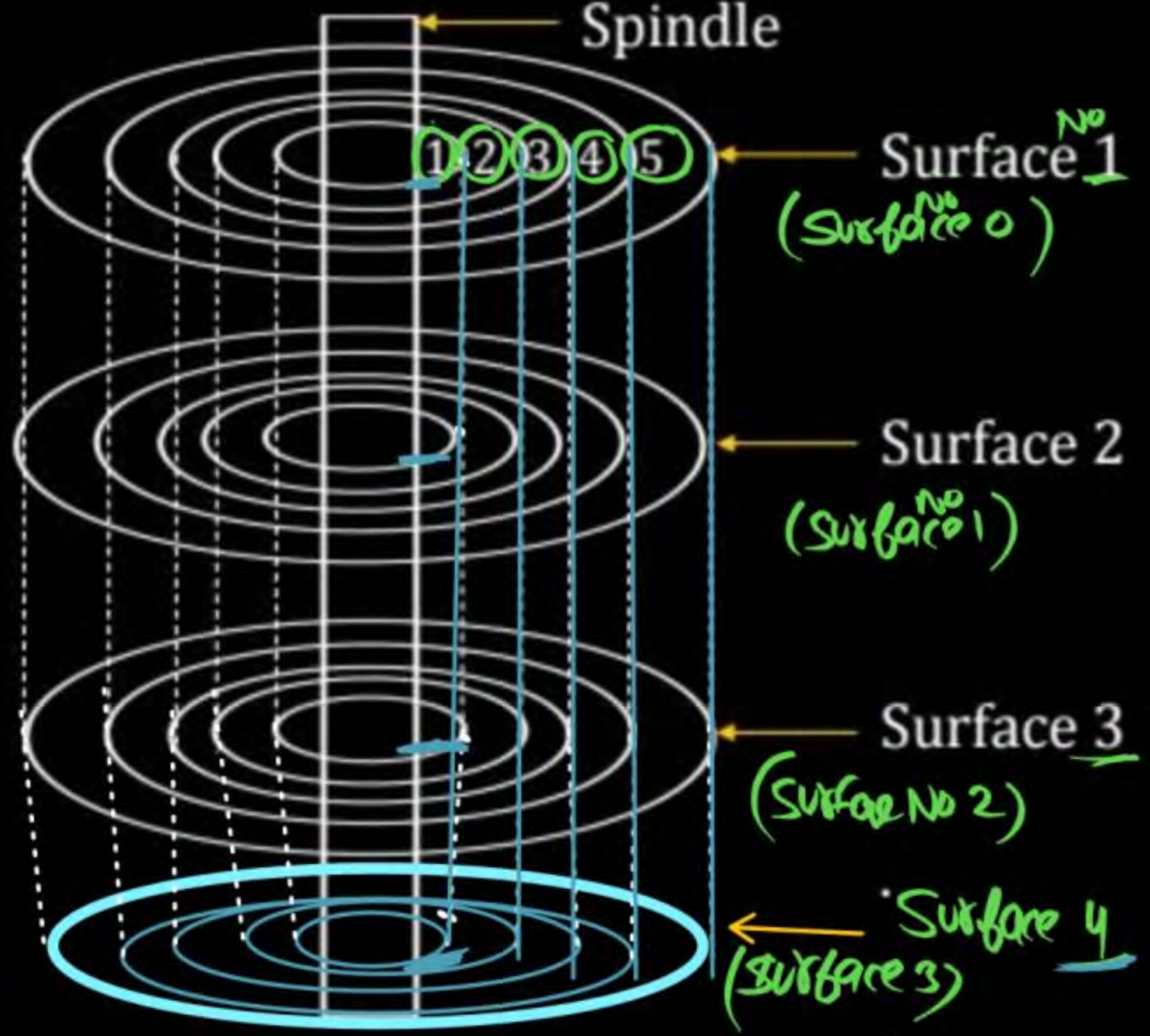
Start from 0 ⇒ <0, 0, 0> I^st sector.

C: Cylinder Number

h: Surface Number

S: Sector Number.

Same track number in all the surface will form a cylinder.



Number of Platter =2

#Surface = 2 X 2 = 4 Surface

Number of Surface =4

Number of track Per Surface =5

Number of Cylinder = 5

Number of Sector Per track =8

Number of Sector Per Cylinder=

Surface = 4

Track Per Surface = 5 [0-4]

cylinder = 5 [0-4]

Number of Sector Per track = 8

Number of sector Per cylinder = # surface x # sectors Per track

= 4 X 8 = 32 Sector.

8 Sector Per Track

Cylinder 0

Surface 0 ⇒ Track 0 = 8 Sector

Surface 1 ⇒ Track 0 = 8 Sector

Surface 2 ⇒ Track '0' = 8 Sector

Surface 3 ⇒ Track 0 = 8 Sector.

→ In 1 Cylinder

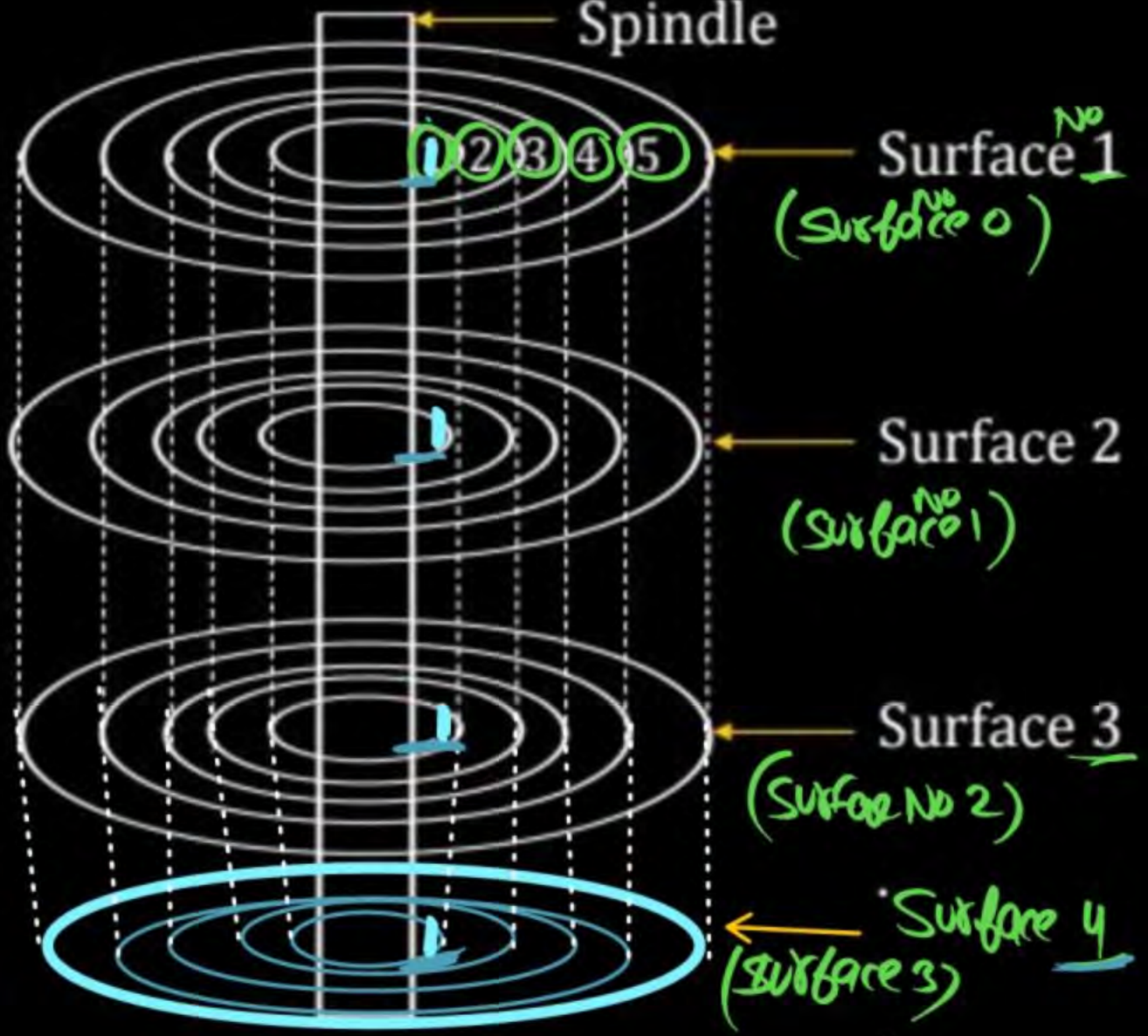
Total # Sector per Cylinder = 4 X 8 = 32 Sector.

8 Sector Per Track

Number of Sector per Cylinder = #surface x #Sectors per track

= 4 X 8 = 32 Sector.

Same track number in all the surface will form a cylinder.



Number of Platter =2

#Surface = 2 X 2 = 4 Surface

Number of Surface =4

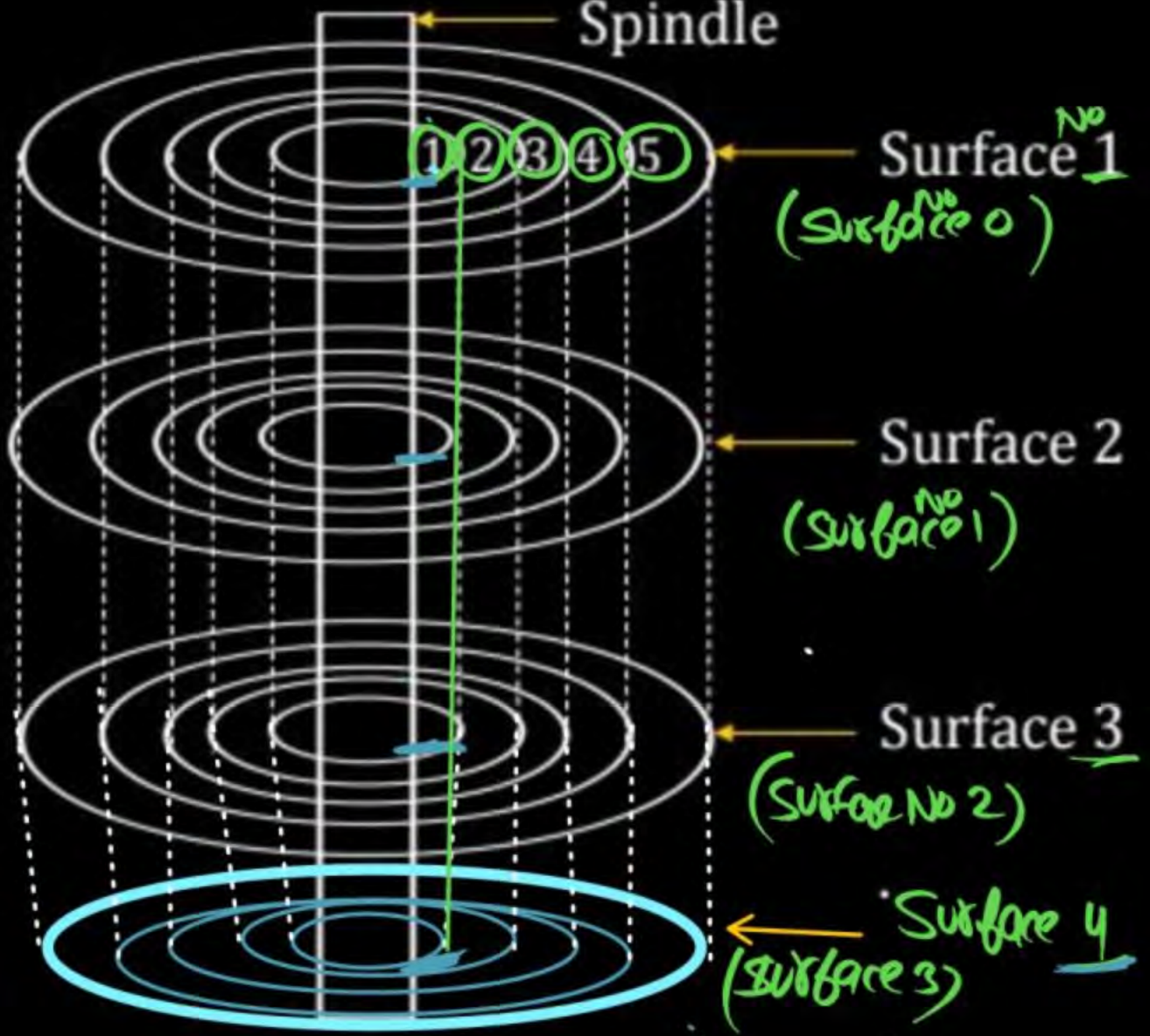
Number of track Per Surface =5

Number of Cylinder = 5

Number of Sector Per track =8

Number of Sector Per Cylinder=

Same track number in all the surface will form a cylinder.



Number of Platter =2

#Surface = 2 X 2 = 4 Surface

Number of Surface =4

Number of track Per Surface =5

Number of Cylinder = 5

Number of Sector Per track =8

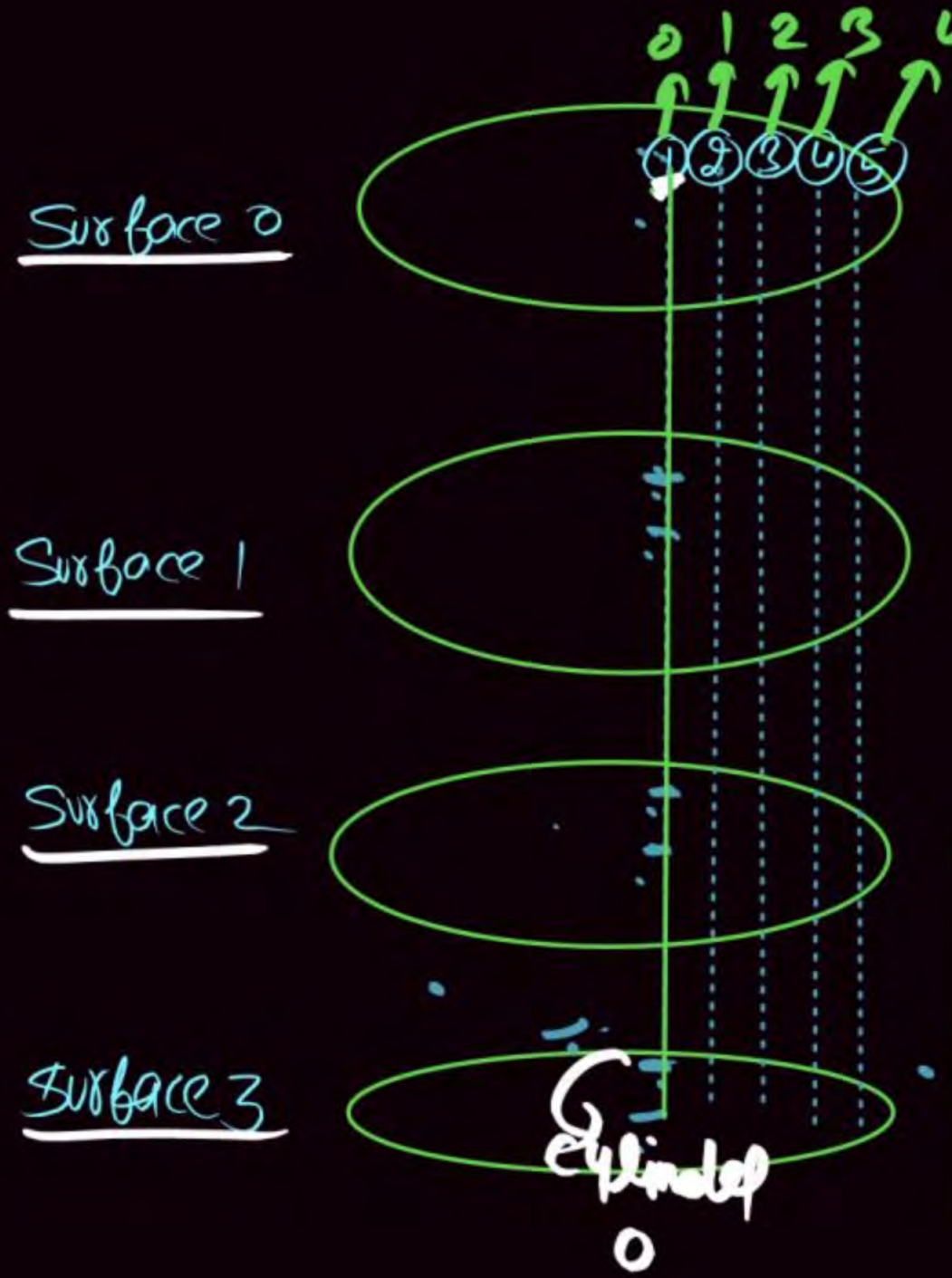
Number of Sector Per Cylinder=

Each Surface track contain 8 Sector.

Note

First we traversed [cross] all Sector of One Track of Surface 0.

then all Sectors of same track at Surface 1.



2 platter & 2 Recording surface

surface = 4

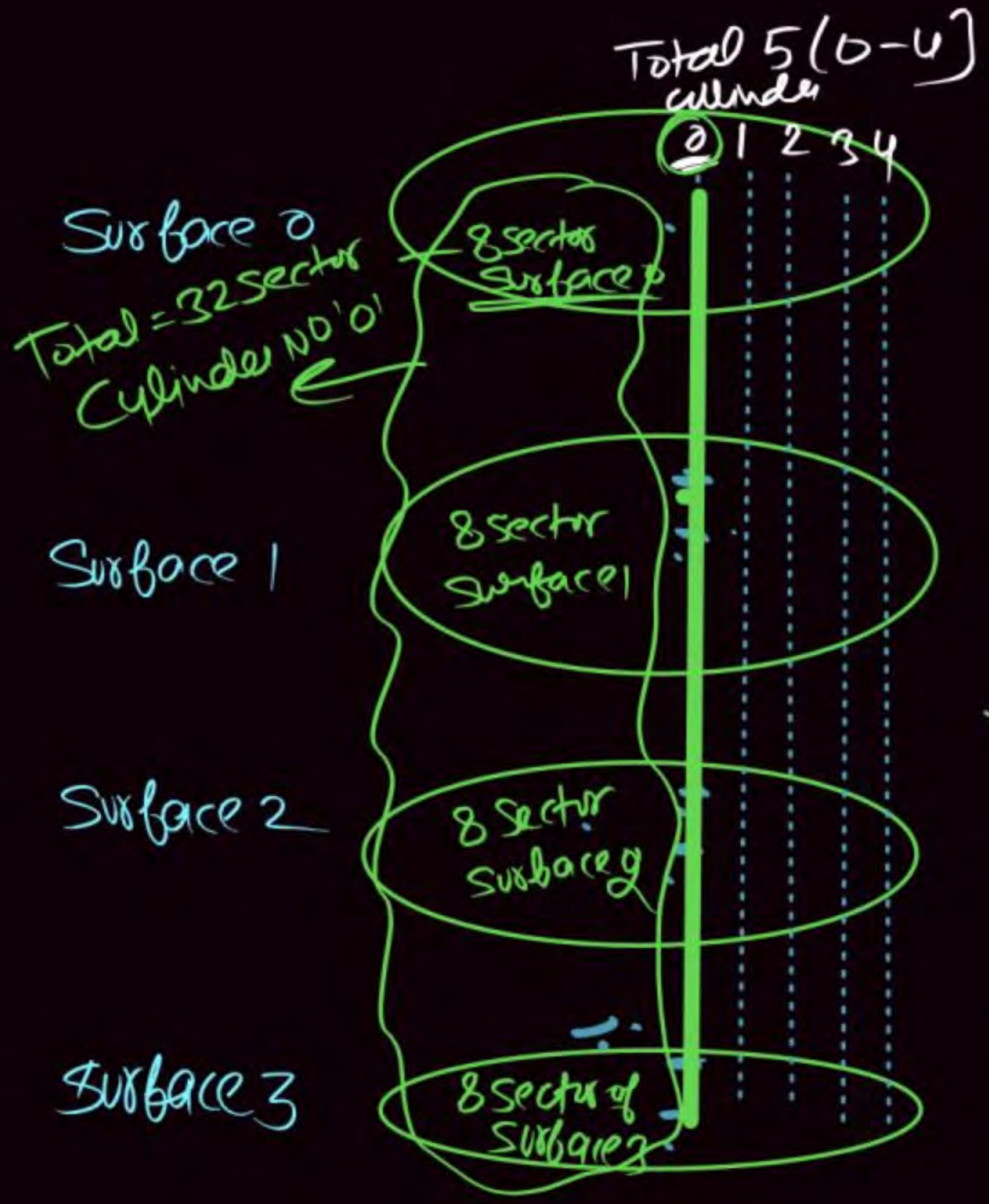
track per surface = 5

cylinder = 5 [0-4]

SECTOR Per Track = 8

SECTOR Per cylinder = 4 X 8

= 32 sector Per cylinder.



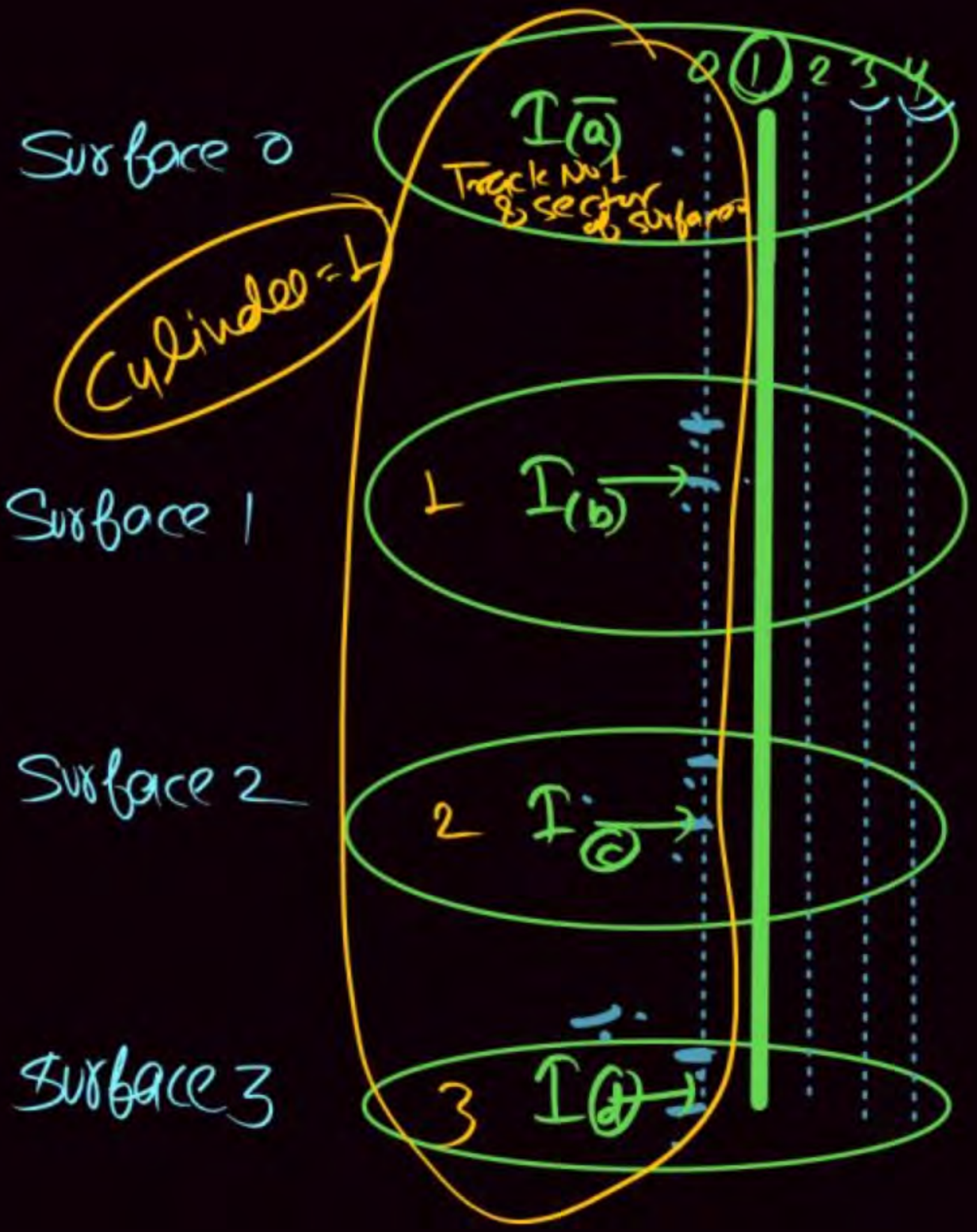
Cylinder NO '0'

Step1: Surface Number 0 (1st surface) one track [track 0] all 8 Sector (0 to 7) traversed

Step2: Surface Number 1 (2nd surface) one track [track 0] all 8 Sector [0 to 7] traversed

Step3: Surface Number 2 [3rd surface] one track [track 0] all 8 Sector [0 to 7] traversed

Step4 Surface Number 3 [4th surface] One track [track 0] all 8 Sector [0 to 7] traversed.



Cylinder No '1'

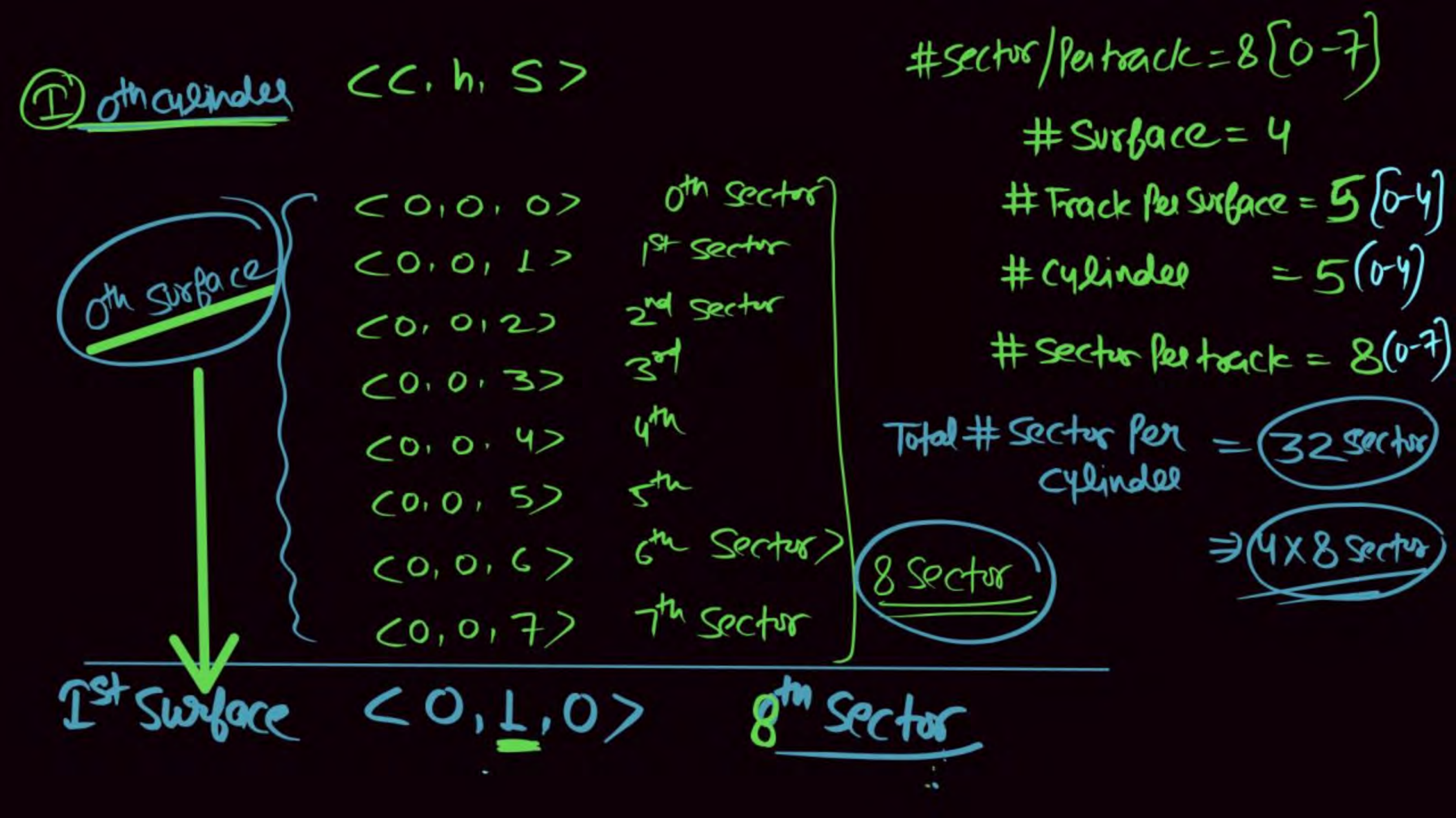
Step1: Surface Number 0 (1st surface) one track [track No 1] all 8 Sector (0 to 7) traversed

Step2: Surface Number 1 (2nd surface) one track [track 1] all 8 Sector [0 to 7] traversed

Step3: Surface Number 2 [3rd surface] one track [track 1] all 8 Sector [0 to 7] traversed

Step4 Surface Number 3 [4th surface] One track [track 1] all 8 Sector [0 to 7] traversed.

(I) 0th cylinder


① 0th cylinder <C, h, S>
#sector/Per track = 8 [0-7]
Surface = 4
Track Per Surface = 5 [0-4]
cylinder = 5 (0-4)
sector Per track = 8 (0-7)
0th surface
<0,0,0> 0th sector
<0,0,1> 1st sector
<0,0,2> 2nd sector
<0,0,3> 3rd
<0,0,4> 4th
<0,0,5> 5th
<0,0,6> 6th Sector>
<0,0,7> 7th sector
8 Sector
Total # sector Per cylinder = 32 sector
⇒ 4 x 8 sector
1st Surface <0,1,0> 8th sector

① 0th cylinder <C, h, S>

#sector/Per track = 8 [0-7]

Surface = 4

Track Per Surface = 5 [0-4]

cylinder = 5 (0-4)

sector Per track = 8 (0-7)

<0,1,0> 8th sector
<0,1,1> 9th sector
<0,1,2> 10th sector
<0,1,3> 11th
<0,1,4> 12th
<0,1,5> 13th
<0,1,6> 14th sector
<0,1,7> 15th sector

8 sector in I st Surface.

Total # sector Per cylinder = 32 sector

⇒ 4 × 8 sector

2nd Surface.

<0,2,0> 16th Sector

① 0th cylinder <C, h, S>

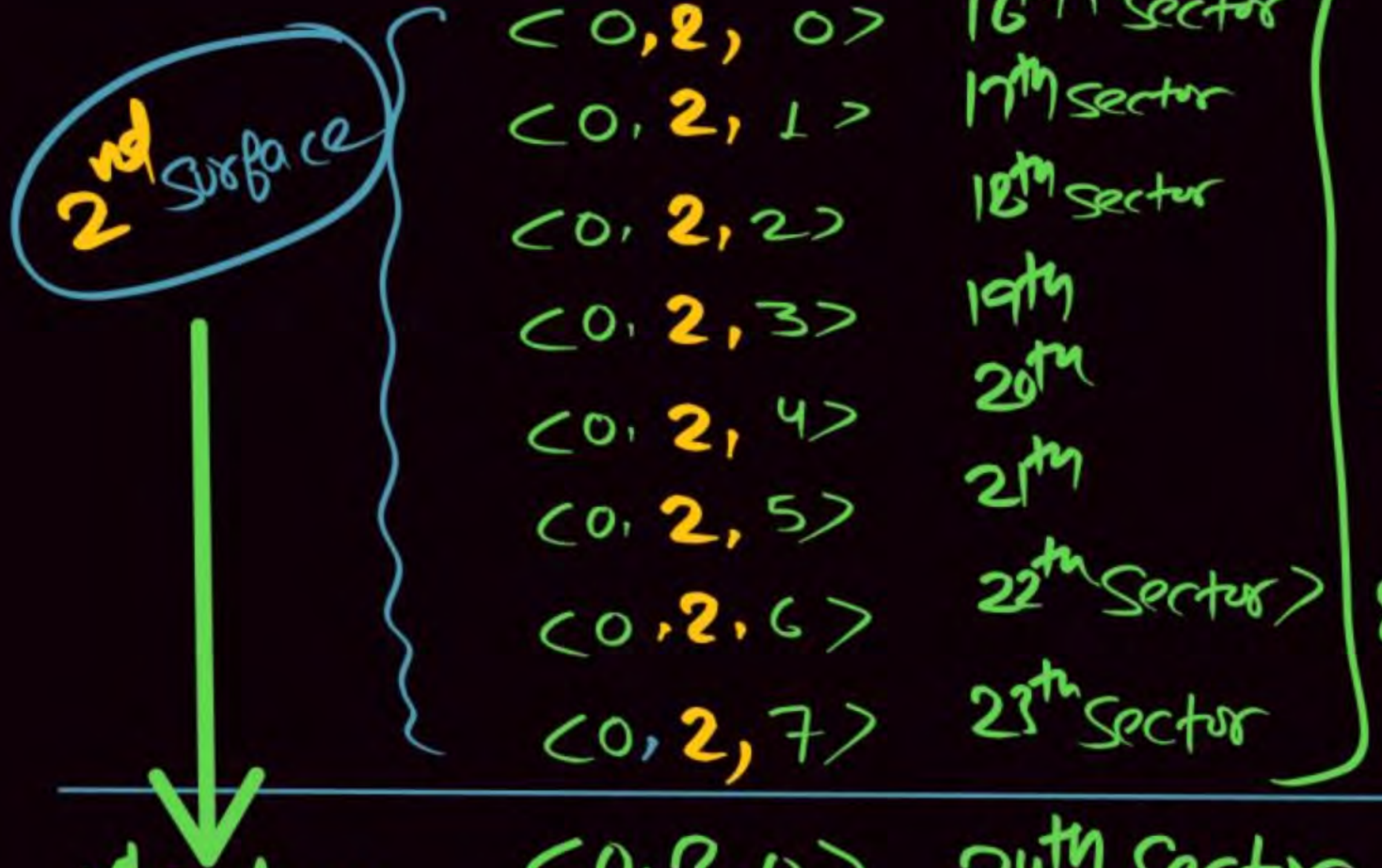
#sector/per track = 8 [0-7]

Surface = 4

Track per surface = 5 [0-4]

cylinder = 5 (0-4)

sector per track = 8 (0-7)



Total # sector per cylinder = 32 sector

⇒ 4 × 8 sector

① 0th cylinder <C, h, S>

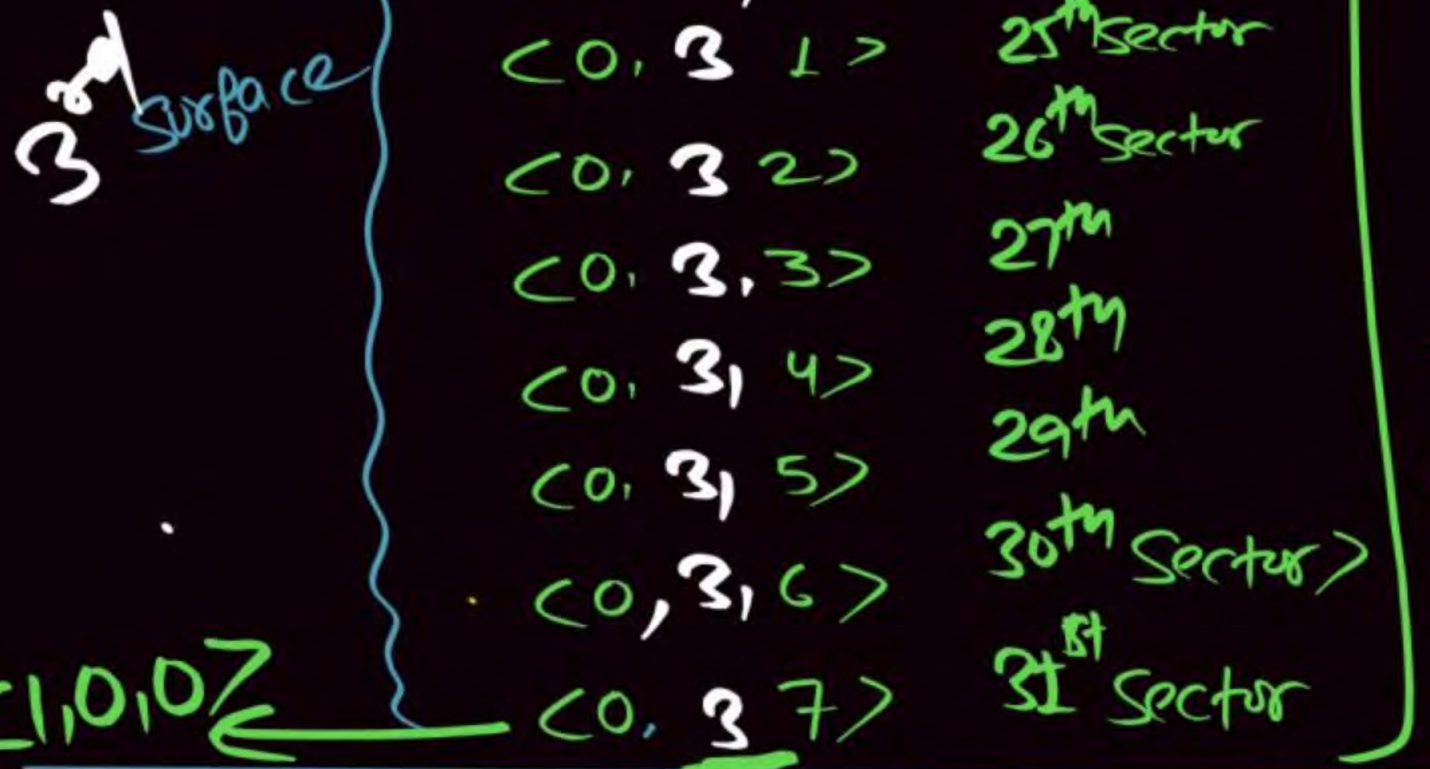
#sector/per track = 8 [0-7]

Surface = 4

Track per surface = 5 [0-4]

cylinder = 5 (0-4)

sector per track = 8 (0-7)



Total # sector per cylinder = 32 sector

8 sector in surface 3. ⇒ 4 × 8 sector

Now 0th cylinder all surface cross (traversed) → now → Next cylinder.

Now cylinder No 1

All 32 sector stored in All 4 Surface
[4 X 8 Sector]

of Cylinder Number '0'

Now Cylinder No '1'

II Cylinder = 'L'

Cylinder No 1

Cylinder No 1 & 0th surface

<1, 0, 0> 32th sector

<1, 0, 1>

<1, 0, 7> 39th sector

Cylinder No 1 & 1st Surface

<1, 1, 0> 40th sector

<1, 1, 7> 47th sector

Cylinder 1 & 2nd Surface

<1, 2, 0> 48th sector

<1, 2, 7> 55th sector

Cylinder 1 & 3rd Surface

<1, 3, 0> 56th sector

<1, 3, 7> 63th sector

∴

These 32 sector (32-63) Stored at cylinder No '1'.

⇓

Now Next Cylinder Cylinder '2'

Now Cylinder '2'.
Address

Cylinder No (2)

Cylinder No (2) & 0th surface

<2, 0, 0> 64th sector
<2, 0, 1> 65

<2, 0, 7> 71th sector

Cylinder No (2) & 1st Surface

<2, 1, 0> 72th sector

<2, 1, 7> 99th sector.

Cylinder (2) & 2nd Surface

<2, 2, 0> 80th sector

<2, 2, 7> 87th sector

Cylinder (2) & 3rd surface

<2, 3, 0> 88th sector

<2, 3, 7> 95th sector

These 32 sector (64-95) stored at cylinder No '2'.

⇓

Now Next Cylinder Cylinder '3'.

Now Cylinder '3'..
address

Cylinder No (3)

Cylinder No (3) & 0th surface
- <3, 0, 0> 96th sector
- <3, 0, 1>
- <3, 0, 7> 103th sector

Cylinder No (3) & 1st Surface
- <3, 1, 0> 104 sector
- <3, 1, 7> 111 th sector

& 2nd Surface
- <3, 2, 0> 112 th sector
- <3, 2, 7> 119 th sector

Cylinder (3) & 3rd Surface
- <3, 3, 0> 120 th sector
- <3, 3, 7> 127 th sector

These 32 sector (96-127) Stored at cylinder No '3'.

⇓

Now Next Cylinder Cylinder '4'

(V) Now Cylinder '4' Address.

⇓

Last Cylinder

(∵ Total 5 Cylinder [0-4].

Cylinder No (4)

Cylinder No (4) & 0th surface

<4, 0, 0> 128th sector

<4, 0, 1>

<4, 0, 7> 135th sector

Cylinder No (4) & 1st Surface

<4, 1, 0> 136th sector

<4, 1, 7> 143th sector

Cylinder (4) & 2nd Surface

<4, 2, 0> 144th sector

<4, 2, 7> 151th sector

Cylinder (4) & 3rd Surface

<4, 3, 0> 152th sector

<4, 3, 7> 160th sector

∴ These 32 sector (128-159) Stored at cylinder No '4'.

Last cylinder (Total Sector = 160) (0 to 159)

Surface = 4

Track/Surface = 5

Sector Per Track = 8

Sector = # Surface X # track/surface X # Sector/Track

$\Rightarrow 4 \times 5 \times 8 =$ 160 Sector

<0,0,0> to <4,3,7>

(Q) What is Sector Number of this address

<4, 3, 7>

<C, H, S>

C → Cylinder, H → Surface, S → Sector

Surface = 4

Cylinder = 5

Sector Per track = 8

Sectors

(i) To Cross 4 Cylinder [0, 1, 2, 3] = 4 × 4 × 8 = 128

for 1 Cylinder Traversed

⇒ 4 Surface × 8 Sector/Track

128 = 32 Sector Per Cylinder

(ii) # Sector to cross 3 Surface [0, 1, 2] ⇒ 3 × 8 = 24

In each Surface = 8 Sector

7th Sector [0, 1, 2, 3, 4, 5, 6]

0 to 6

+ 7

159

Sector No 159

Q for Previous DATA What is the Sector Address <4, 2, 3>.

Sector.

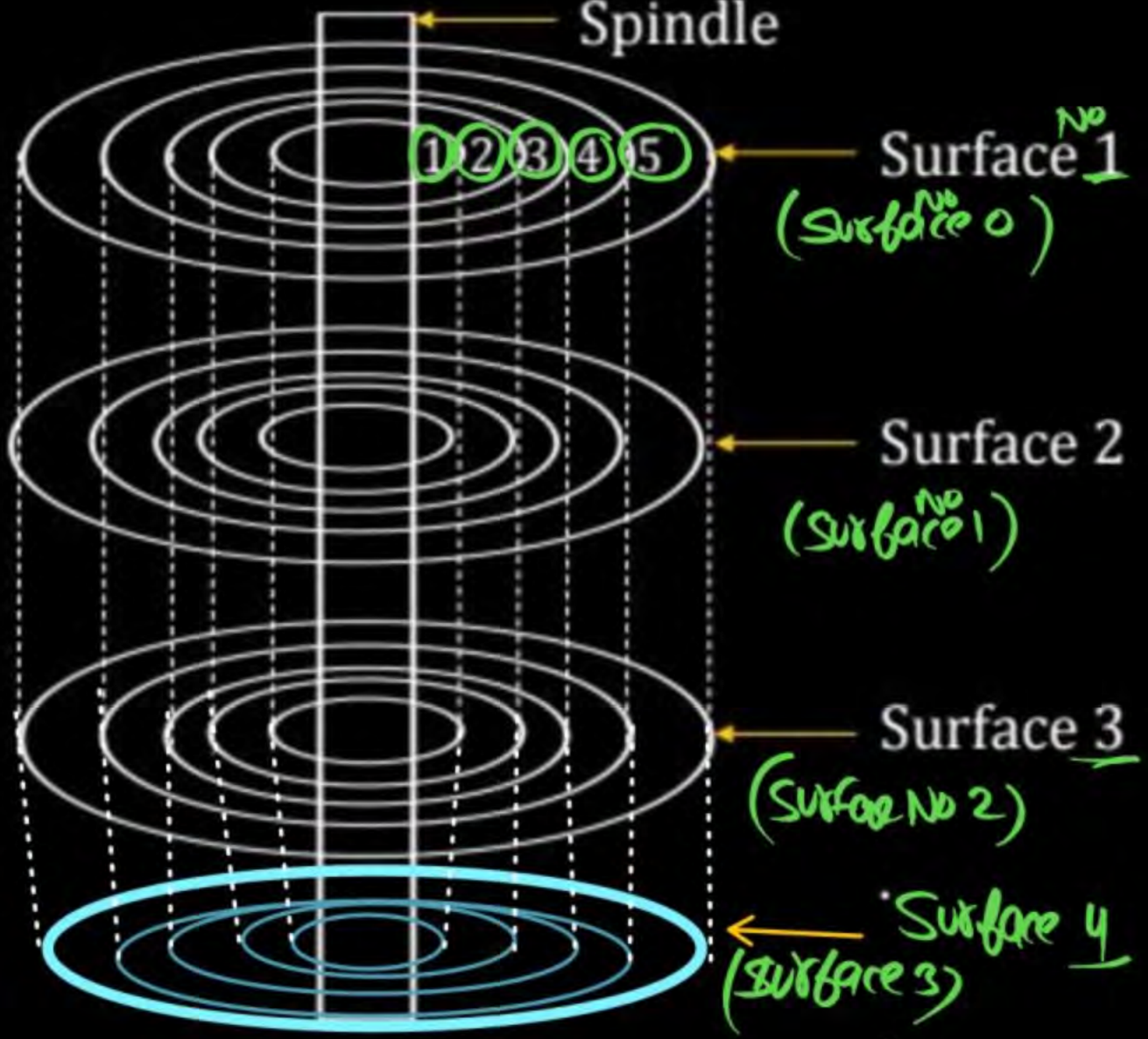
(i) To Cross 4 Cylinder [0-3] # Sector = 4 X 4 X 8 = 128

(ii) To Cross 2 Surface (0, 1) # sector traversed = 2 X 8 = 16

(iii) To Cross '3' (0, 1, 2) # Sector traveled = 3

147

Same track number in all the surface will form a cylinder.



Number of Platter =2

#Surface = 2 X 2 = 4 Surface

Number of Surface =4

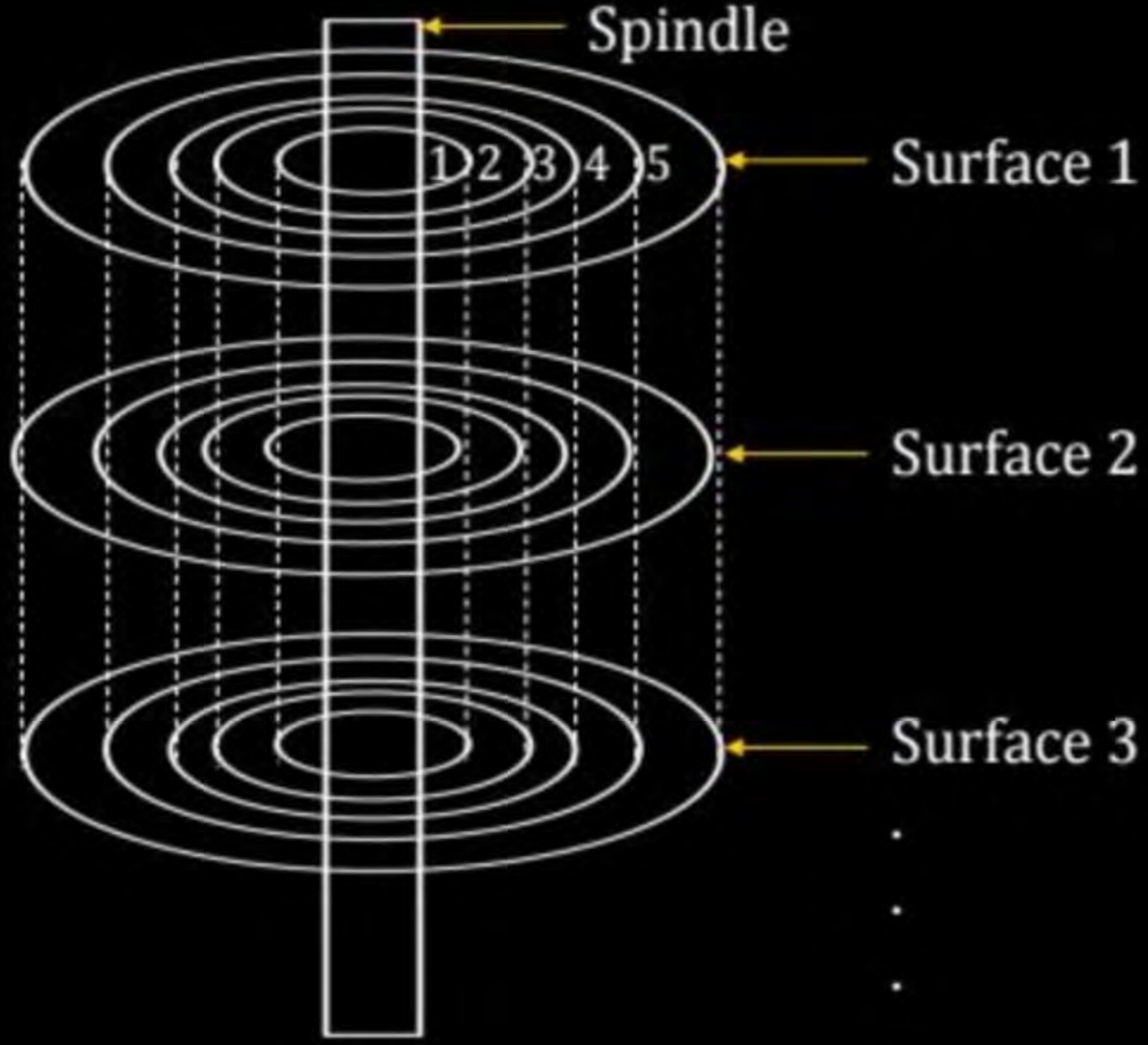
Number of track Per Surface =5

Number of Cylinder =

Number of Sector Per track =8

Number of Sector Per Cylinder=

Same track number in all the surface will form a cylinder.



Number of Platter =2

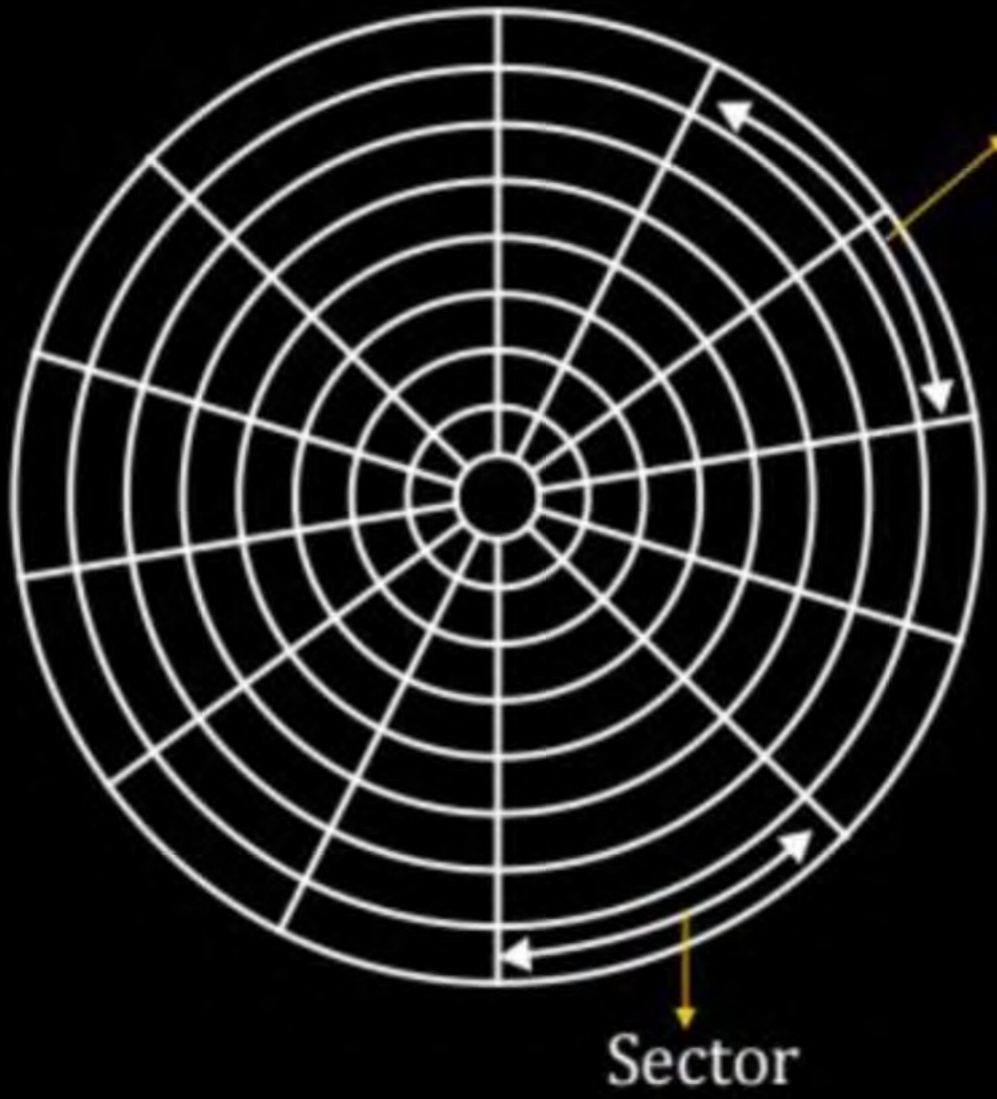
Number of Surface =4

Number of track Per Surface =5

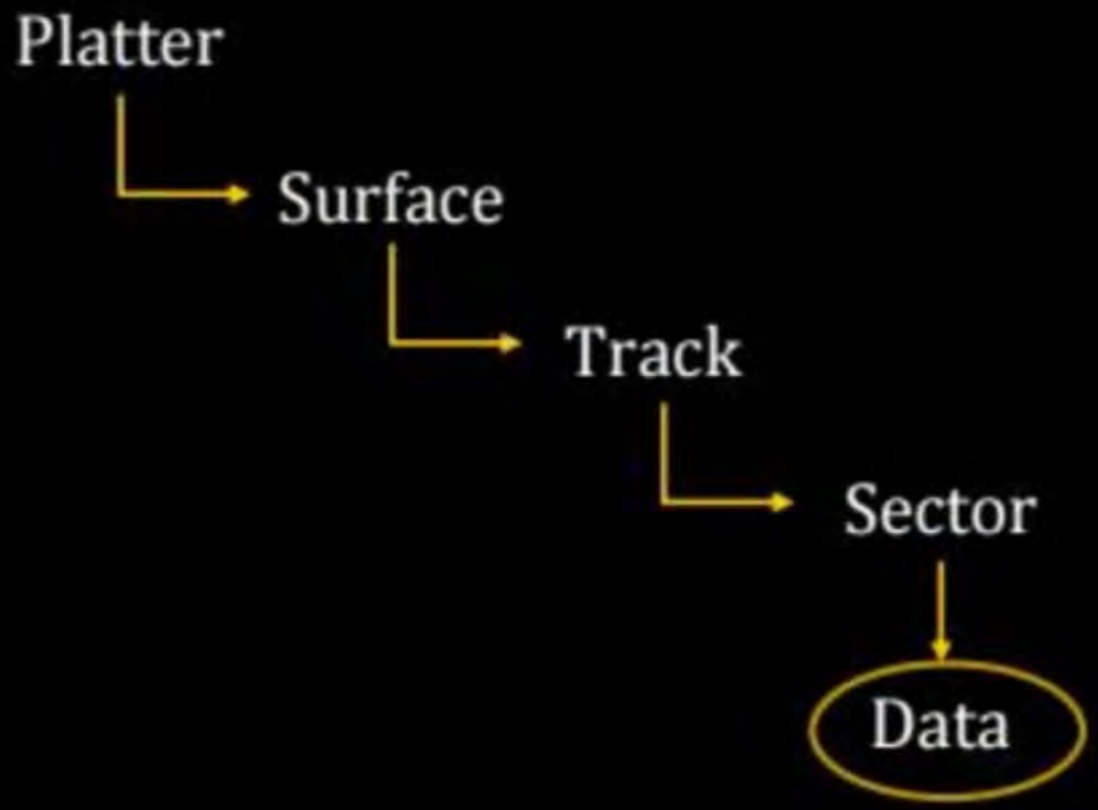
Number of Cylinder =5

Number of Sector Per track =8

Number of Sector Per Cylinder=32



Sector
Or
Disk Block


Platter
Surface
Track
Sector
Data

Q. Consider a disk which has 16 platter, each platter has two surface. Every surface has 1K Track is further Divided into 512 sector and every sector can store the 8KB Data, then calculate.

(i) What is the capacity of Disk?

(i) How many bits are required to identify any particular sector of the Disk?

Solution (i) 1 platter - 2 surface

16 platter - 16 × 2 i.e. 32 surface

1 surface - 1K Track

32 surface - 32 × 1K track ⇒ 32K Track

1 track - 512 sector

32k Track ⇒ 32K × 512 sector

Each sector capacity ⇒ 2KB

Total Disk capacity = 32k × 512 × 8KB

$= 2^5 \times 2^{10} \times 2^9 \times 2^{13} \Rightarrow 2^{37}$ B

Disk capacity = 128 GB

(ii) #bits required to represent sector in a disk

$= 16 \times 2 \times 1k \times 512$

$= 2^4 \times 2^1 \times 2^{10} \times 2^9 \Rightarrow 2^{24}$ = 24 bits

Common Data for next two questions:

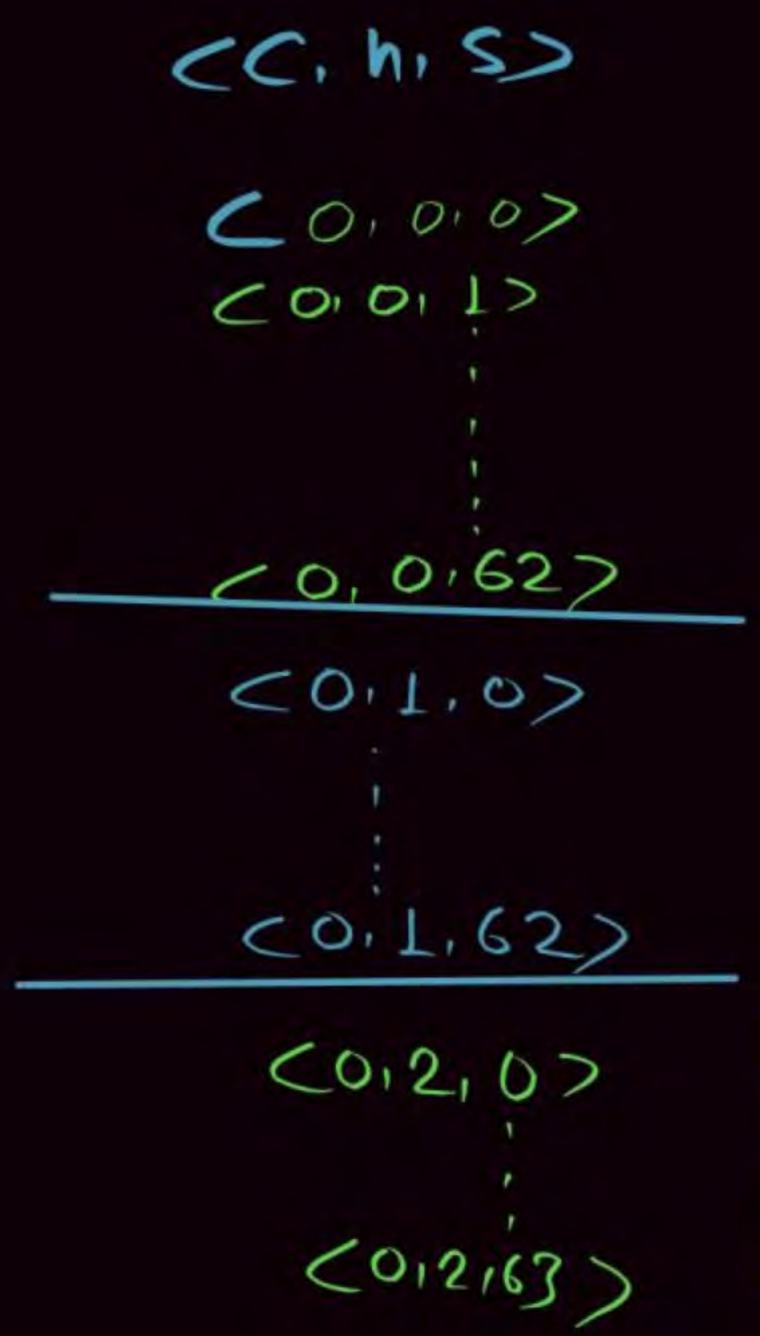
A hard disk has 63 sectors per track, 10 platters each with 2 recording surfaces and 1000 cylinders. The address of a sector is given as a triple ⟨c,h,s⟩, where c is the cylinder number, h is the surface number and s is the sector number. Thus, the 0^{th} sector is addressed as⟨0,0,0⟩, the 1^{st} sector as ⟨0,0,1⟩, and so on.

Surface = 10 × 2 = 20 Surface.

Sector Per track = 63 Sector / Track.

Sector Per Cylinder = # track/surface × # Sector Per track

= 20 × 63 = 1260 sector in One Cylinder



<0, 19, 0>

Last Address of 0th cylinder

① <0, 19, 62>

② <1, 0, 0> I^st Address of 1^st cylinder

Q.1 What is last sector address of 0th cylinder in <C, h, s>

Q.2 What is I^st sector address of I^st cylinder. <C, h, s>

MCQ

The address ⟨400,16,29⟩ corresponds to sector number:

[GATE-2009-CS: 2M]

A 505035

B 505036

C 505037

D 505038

<400, 16, 29>

#Sector for 400 ⇒ 400 X (10 X 2) X 63

#track/cylinder #sector/Track

= 504,000

#Sector for 16 Surface ⇒ 16 X 63 = 1008

#Sector for 29 Sector ⇒ 29

29

505037

OR 400 X (20 X 63)

Surface X #sector per surface

OR

400 X (1260)

#sector per Cylinder

C: cylinder
h: surface
S: sector

<C, h, S>

ST: # sector per track

TC: # track per cylinder (# surface)

⇒ 2 * 10 = 20 tracks

$$\text{Sector Number} = S + ST * h + ST * TC * C$$

$$\text{Sector Number} = S + (ST * h) + (SC \times C)$$

SC: # sector per cylinder

<400, 16, 29) ⇒ 29 + 63 * 16 + 63 * 20 * 400

C, h, S

= 505037

MCQ

The address of 1039th sector is

[GATE-2009-CS: 2M]

A ⟨0,15,31⟩

B ⟨0,16,30⟩

C ⟨0,16,31⟩

D ⟨0,17,31⟩

1 Cylinder = 20 × 63 = 1260 sectors

given 1039 so available in Very First cylinder '0'th Cylinder.

⟨0, 15×63 + 31⟩ = 976

⟨0, 16×63 + 30⟩ = 1038

⟨0, 16×63 + 31⟩ = 1039

⟨0, 17×63 + 31⟩ = 1102.

<c, h, s> ← Sector given 1039

$C = \left\lfloor \frac{1039}{1260} \right\rfloor = 0$ **C=0**

1 Cylinder = 20 X 60 Sector
= 1260 Sector.

$h = \frac{1039}{63} = \lfloor 16.49 \rfloor$ **h=16**

1039 % 1260 = 1039

How Much Sector Remaining = 1039 − (16 X 63)
(h x # sector/track)

= 31 = S

<0, 16, 31>.

$$C_{[\text{Cylinder No}]} = \left\lfloor \frac{\text{Given Sector}}{\#\text{sector Per cylinder}} \right\rfloor$$

$$h_{[\text{Surface}]} = \left\lfloor \frac{[\underbrace{\text{Given Secto} \;\%\; \#\text{sector Per cylinder}}_{x}]}{\#\text{Sector Per Track}} \right\rfloor$$

$h = x$

Given No $-$ $x \times$ #Sector Per Head

OR

$x \;\%\; \#$ Sector Per track.

THANK YOU!