[8 points] Consider a single-platter disk with the following parameters: rotation speed: 3600 rpm; number of tracks on one side of platter: 15,000; number of sectors per track: 300; seek time: 2 ms for every hundred tracks traversed. Let the disk receive a request to read 5 consecutive sectors starting at a random sector on a random track and assume the disk head starts at track 0.

(a) What is the average seek time?

(b) What is the average rotational latency?

(c) What is the transfer time for one sector?

(d) What is the total average time to satisfy the request?

Solution

2. (a) 14,999/2 tracks are traversed on average

(8) $\Rightarrow$ Av. seek time $= \frac{14,999}{2} * \frac{2\,ms}{100} = 149.99\,ms$

(b) Av. rot. delay $= \frac{1}{2r} = \frac{60 * 10^3}{2 * 3600} = 8.33\,ms$

(c) Transfer time for a sector $= \frac{\text{Transfer time for a track}}{300}$

$= \frac{60 * 10^3 / 3600}{300} = 0.056\,ms$

(d) Time to satisfy request =

$149.99 + 8.33 + 5 * 0.056$

$= 158.603$

[6 points] Consider a magnetic disk in which the physical addresses (2,4,9) and (3,5,4) are mapped to the logical addresses 1288 and 1859, respectively.

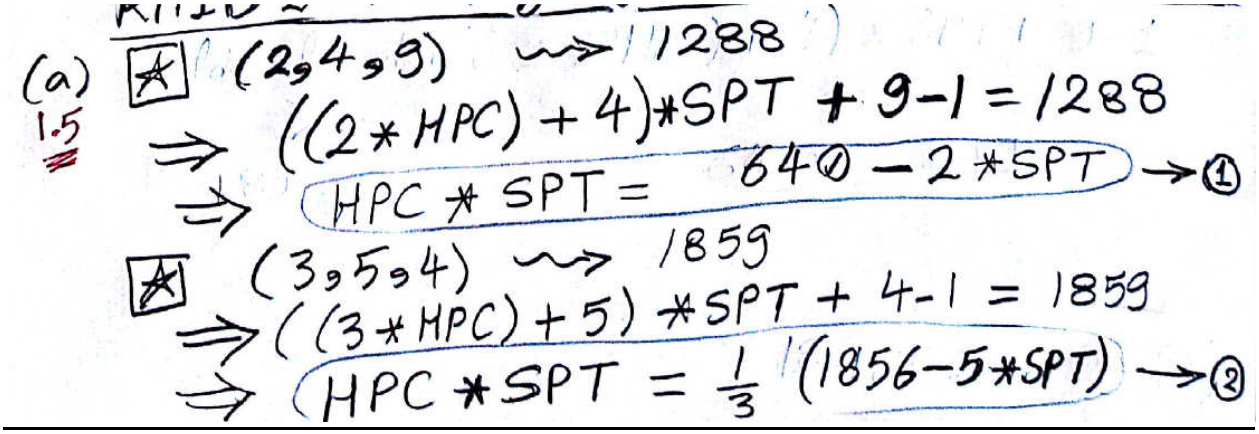
(a) What is the number of sectors per track?

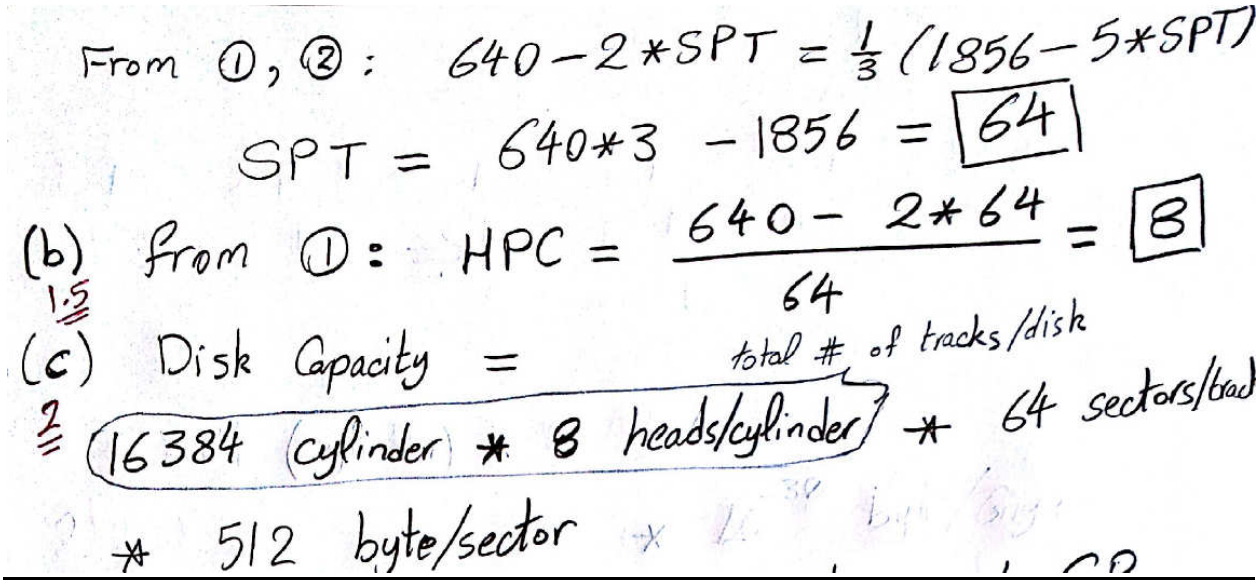
(b) What is the number of heads per cylinder?

(c) What is the disk capacity (in GB) knowing that the capacity of each sector is 512 byte, and each platter surface has 16384 tracks.

(d) What is the maximum data transfer rate (in Mbps) knowing that the spindle speed is 5400 rpm.

Solution





(d) Maximum data rate =

= # of tracks/sec * track capacity

= $\frac{5400 \text{ track/min}}{60 \text{ sec/min}}$ * 64 sector/track * 512 B/sec

= 2,949,120 B/s

= 2,949,120 * $\frac{8}{10^6}$ Mb/s ← Mega bit per second (Mbps)

= 2,949,120 * $\frac{8}{2^{20}}$ Mib/s ← Mebi bit per second

[9 points] Consider a magnetic disk with the following parameters: 300 GB capacity; 3 double-sided platters; 7200 rpm spindle speed; 32768 tracks per side; 4096 bytes per sector; 1 ms seek time for

each thousand tracks traversed.

(a) What is the number of heads per cylinder?

(b) What is the number of sectors per track?

(c) Suppose the heads are initially positioned at cylinder 0 and then the disk receives a request to read a 120 KB block of data stored on consecutive sectors starting at logical address 4800499.

i. What is the physical address of the starting sector of the block?

ii. What is the seek time taken to satisfy this read request?

iii. What is the transfer time taken to satisfy this read request?

Solution

2. (a) 3 double-sided platters $\Rightarrow$ HPC = 3 * 2 = 6 (1)

(b) Capacity = HPC * Tracks per side * SPT * bytes per sector (2)

$300 * 2^{30}$ B = 6 * 32768 * SPT * 4096 B

SPT = 400

ii. The physical address (C, H, S) of the starting sector (whose LBA = 4800499)

$C = LBA \div_{int} (SPT * HPC) = 2000$

$H = (LBA \div_{int} SPT) \bmod HPC = 1$

$S = (LBA \bmod SPT) + 1 = 100$

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iii. Transfer time $= \frac{b}{rN}$

$$= \frac{\overbrace{120 * 2^{10}}^{b}}{\underbrace{(7200/60)}_{r} * \underbrace{400 * 4096}_{N}}$$

$= 625$ μsec
