

Q1.

### Problem 1

$$\begin{aligned}\text{Disk Size} &= 2 * \text{number of platters} * \text{tracks} * \text{sectors} * \text{bytes per sector} \\ &= 2 * 5 * 8,000 * 208 * 512 \\ &= 10 * 8,000 * 208 * 512 \\ &= 10 * 1,664,000 * 512 \\ &= 16,640,000 * 512 \\ &= 8,519,680,000 \text{ Bytes} \\ &\rightarrow \boxed{8.51968 \text{ GB}}\end{aligned}$$

Q2.

$$\begin{aligned}8 \text{ kb} * 1024 &= 8,192 \text{ bytes per block} \\ 8,519,680,000 \text{ bytes} / 8,192 \text{ bytes per block} \\ &= \boxed{1,040,000 \text{ blocks}}\end{aligned}$$

Q3.

$$8,192 / 512 = 16 \text{ sectors}$$

$$\begin{aligned}\text{Minimum} &= \text{Seek time} + \text{Rotational Latency} + \text{Transfer time} \\ &= 0 \text{ ms} + 0 \text{ ms} + 0.05(16) \text{ ms} \\ &= 0 \text{ ms} + 0 \text{ ms} + 0.8 \text{ ms} \\ &= \boxed{0.8 \text{ ms}}\end{aligned}$$

$$\begin{aligned}\text{Maximum} &= \text{Seek time} + \text{Rotational Latency} + \text{Transfer time} \\ &= [1 + \text{tracks} (1/500)] + [(1/(5400/60)) * 1,000] + 0.8 \text{ ms} \\ &= [1 + 8000(1/500)] + [1/90 * 1,000] + 0.8 \text{ ms}\end{aligned}$$

$$= [1 + 16] + [11.1] + 0.8 \text{ ms}$$

$$= 17 \text{ ms} + 11.1 \text{ ms} + 0.8 \text{ ms}$$

$$= \boxed{28.9 \text{ ms}}$$

Average =  $\frac{\text{Seek time}}{2} + \frac{\text{Rotational Latency}}{2} + \text{Transfer time}$

$$= \frac{1}{2}(17) + \frac{1}{2}(11.1) + 0.8$$

$$= 8.5 \text{ ms} + 5.55 \text{ ms} + 0.8 \text{ ms}$$

$$= \boxed{14.85 \text{ ms}}$$

→ rounding intermediary calculations yields:

$$= \boxed{15.4 \text{ ms} (9 + 5.6 + 0.8)}$$

Q4.

$$8192 \text{ bytes per block} / 128 \text{ bytes per record} = \boxed{64 \text{ records per block}}$$

$$100,000 \text{ records} / 64 \text{ records per block} = 1,562.5$$

or

$$\boxed{1,563 \text{ blocks}}$$

$$1,563 \text{ blocks} * 16 \text{ sectors} = \boxed{25,008 \text{ sectors}}$$

Q5.

$$\overbrace{[1 + 100(1/500)]}^{\text{tracks}} + \overbrace{1/2(11.1)}^{\text{half rotation}} + \overbrace{(10 * 0.8)}^{\text{seek time}} \underbrace{\hspace{1cm}}_{\text{blocks}}$$

$$= 1.2 \text{ ms} + 5.6 \text{ ms} + 8 \text{ ms}$$

$$= \boxed{14.8 \text{ ms}}$$

Q6.

$$208 \text{ sectors per track} / 16 \text{ sectors per block} = 13 \text{ blocks per track}$$

$$13 \text{ blocks per track} * 10 \text{ surfaces} = \boxed{130 \text{ blocks per cylinder}}$$

Q7.

The best way to store these blocks on disk to speed up the sequential read is to align them under each other among the inner most cylinder on all ten surfaces. This will ensure that the first ten blocks will be read in 0.8 ms. The next ten blocks would be on the next 16 sectors per surface following the direction of rotation on the cylinder. The following ten blocks are to be written on the one cylinder outside of the innermost. Moving the disk arms outward should take 1.002 ms, continuing in this same pattern should give us the most optimal read time.

Average:

$$14.05 + \left( \frac{0.8 * x}{10} \right) + \left( \text{floor} \left( \frac{x}{130} \right) * 1.002 \right), \text{ ms}$$

$x$  = number of blocks

14.05  $\rightarrow$  (8.5 + 5.55) rotational latency and seek time

$\frac{0.8 * x}{10} \rightarrow$  10 blocks read at one time

$\frac{x}{130} \rightarrow$  number of cylinders to store, 1.002 = time to seek next cylinder

using formula for file

$$14.05 + \left( \frac{0.8 * 1,563}{10} \right) + \left( \text{flr} \left( \frac{1,563}{136} \right) * 1.002 \right)$$

$$14.05 + 125.04 + 12.024 = \boxed{151.114 \text{ ms}}$$

## Problem 2

Q1.

4-byte boundaries:

Header	ID	Name	Age	DoB	Gender	Addr.	State
8	4	28	4	12	4	60	4

$$\text{Sum} = \boxed{124 \text{ bytes}}$$

Q2.

8-byte boundaries:

Header	ID	Name	Age	DoB	Gender	Addr.	State
8	8	32	8	16	8	64	8

$$\text{Sum} = \boxed{152 \text{ bytes}}$$

Q3.

4-byte boundary

$$4 \text{ k bytes} * 1024 = 4,096$$

$$\text{floor}[(4 \cdot 1024 - 64) / 124] = \boxed{32 \text{ records}}$$

8-byte boundary

$$4 \text{ k bytes} * 1024 = 4,096$$

$$\text{floor}[(4 \cdot 1024 - 64) / 152] = \boxed{26 \text{ records}}$$