Problem 1

Q1

$$\text{Disk capacity} = 10 \text{ surfaces} \times 8000 \text{ tracks} \times 208 \text{ sectors} \times 512 \text{ Bytes}$$

$$\text{Disk capacity} = 8519680000 \text{ B} = 8320000 \text{ KB} = 8125 \text{ MB} = \mathbf{7.935 \text{ GB}}$$

Q2

$$8519680000 \text{ B} \div 8192 \text{ Bytes per block} = \mathbf{1040000 \text{ blocks}}$$

Q3

	Seek time		Rotational latency		Transfer time		Total
Minimum	0 ms	+	0 ms	+	0.8 ms	=	**0.8 ms**
Maximum	17 ms	+	11.1 ms	+	0.8 ms	=	**28.9 ms**
Average	9 ms	+	5.6 ms	+	0.8 ms	=	**15.4 ms**

Q4

- 8192 Bytes per block $\div$ 128 Bytes per record = **64 records per block**
- 100000 records $\div$ 64 records per block = **1563 blocks**
- 1563 blocks $\times$ 16 sectors per block = **25008 sectors**

Q5

5.6 ms (initial half rotation) + 1.2 ms (seek time) + 8 ms (transfer time) = **14.8 ms**

Q6

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

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

Q7

The most efficient way to store blocks in a file, in order to speed up the sequential read of that file, is to start with B_1, B_2, ... B_{10} aligned under each other on all ten surfaces of the innermost cylinder. This way, once the disk arms are in position the first ten blocks can all be read in 0.8 ms. Then the next ten blocks should be in the next sixteen sectors per surface in the direction of rotation on the same cylinder. This should continue until all 130 blocks on the innermost cylinder are filled. Then, the next ten blocks should be written on the second-to-innermost cylinder approximately 10% of the circumference of the disk away from where B_{130} was written. Once the disk arms are done reading B_{130},

they need to move out to the second-to-innermost track, which takes about 1.002 ms. In this time, the disk will have rotated by about 9.027%, so if B_{131} starts about 10% of the disk circumference away from B_{130} the disk arms will arrive at the right track just in time to start reading it. Continue in the same spiral pattern out from the center of the disk until B_{last}.

The average time to read this file is, in milliseconds:

$$14.6 + \frac{0.8n}{10} + \left(\left\lfloor \frac{n}{130} \right\rfloor \times 1.002\right)$$

Where n is the number of blocks in the file. The 14.6 ms accounts for initial 5.6 ms of rotational latency and 9 ms of seek time. The time to read each block is 0.8 ms, multiplied by n divided by 10 (because ten blocks are read at a time). The final component is the floor of $\frac{n}{130}$, which is the number of cylinders necessary to store the file, multiplied by the 1.002 ms it takes to seek to the next cylinder while reading.

A file with 100,000 records, with each record being 128 bytes, would have 1,563 blocks. This file's average read time would be:

$$14.6 + \frac{(0.8 \times 1563)}{10} + \left(\left\lfloor \frac{1563}{130} \right\rfloor \times 1.002\right) = \mathbf{151.7\ ms}$$

Problem 2

4-byte		8-byte	
Field	Index	Field	Index
Header	0	Header	0
ID	8	ID	8
Name	12	Name	16
Age	40	Age	48
DoB	44	DoB	48
Gender	56	Gender	72
Address	60	Address	80
State	120	State	144

Q1

Each record would be 128 bytes.

Q2

Each record would be 152 bytes.

Q3

4-Byte Boundaries

$$4096\ \text{B} = 64\ \text{B} + (128\ \text{B} \times n)$$

$$n = \mathbf{31\ records}$$

8-Byte Boundaries

$$4096 \text{ B} = 64 \text{ B} + (152 \text{ B} \times n)$$

$$n = \textbf{26 records}$$