Name: Date:
Group members: Class:

Estimating Storage Capacity Worksheet Answers

1. **Calculate d**

$$d = \frac{m\lambda}{\sin q}$$

- *d* is the spacing of the structure (here: track pitch)
- *θ* is the angle of the *m*[th] diffracted ray
- *m* is the *order* of the diffracted ray. Here we only use the first order, i.e. m=+1, -1

To get a better estimate for d, calculate the average $d_{mean} = \frac{d_{+1} + d_{-1}}{2}$ in the last column.

	Laser color	Wavelength (nm)	θ, m=+1	θ,m=-1	d, m=+1	d, m=-1	d_{mean}
CD	red	650	30	28	1300 nm	1385 nm	1343 nm
DVD	red	650	63	62	730 nm	736 nm	733 nm

2. **Estimate the storage**
   Using your measured distance d between tracks, how many tracks fit on a disc if 33mm are writable?

   Sample Calculations for a CD: $\frac{33mm}{1343\ nm} x\ \frac{1\ nm}{10^{-6}mm} = 24,572$

   Sample Calculations for a DVD: $\frac{33mm}{733\ nm} x\ \frac{1\ nm}{10^{-6}mm} = 45,020$

   (Answer: Typically, CD around 20,000, DVD around 45,000)

   A CD track has around 270,000 pits. A DVD track fits around 500,000 pits because the pits are smaller. How many pits fit on a CD and DVD?

   Sample Calculations for a CD: 24,572 x 270,000 = 6,634,440,000 = 6.6×10^9

Estimating the Storage Capacity of a CD/DVD Worksheet Answers

Sample Calculations for a DVD: 45,020 x 500,000 = 22,510,000,000 = 2.25×10^{10}

(Answer: Typically, CD around 5.4×10^9, DVD around 2.25×10^{10})

Divide the number by 8 to get an estimate of the storage in bytes. Compare with the info on the CD/DVD. Note that the DVD has two layers.

Sample Calculations for a CD: $\frac{6.6 \times 10^9}{8} = 825,000,000 = 825 \times 10^6 = 825\ MB$

Sample Calculations for a DVD: $\frac{2.25 \times 10^{10}}{8} = 2,812,500,000 = 2.8 \times 10^9 = 2.8\ GB$ x 2 layers = 5.6 GB

(The answer should be close to 700MB for the CD and 4.7GB for the DVD. Note that 1MB=10^6 bytes=8×10^6 bits and 1GB=10^9 bytes=8×10^9 bits, hence the division by 8.)

3. **Blu-ray discs** need special readers that rely on blue lasers. How can a Blu-ray disc store more information? Why is the laser blue?

(Answer: The name blue ray comes from the blue laser. A blue ray can store more information because the distance between the pits, and the pits themselves, are smaller than what was investigated in this activity. The dimension of the pits and their separation is smaller than the wavelength of red and even green lasers. Therefore, a laser with smaller wavelength is needed.)

4. What are two advantages of using digital media to store data? What is a disadvantage?

(Answer: Advantages may include the ability to store large amounts of information in a small space, that information can be stored reliably, and that it can be copied, transferred, and shared quickly. Disadvantages include issues with easy deletion and security/theft.)