**Digital Information Storage Objectives A-L**

**Objective A: Binary to decimal**

Problems:

1. Convert 10110110 to decimal. (182)
2. Convert 11011011 to decimal. (219)
3. Convert 00010111 to decimal. (23)

**Objective B: Decimal to Binary**

Problems:

1. Convert 213 to an 8 bit binary. (11010101)
2. Convert 117 to an 8 bit binary. (01110101)
3. Convert 247 to an 8 bit binary. (11110111)
4. Convert 129 to an 8 bit binary. (10000001)

**Objective C-D: The advantages of digital information storage, and bit rate vs. sample depth.**

Questions:

1. What is the difference between a digital and an analog signal?
2. How is analog converted to digital?
3. What is meant by bit rate, and sample depth?
4. What are the advantages of digital information storage?

**Objective E-F: Storing information on CDs**

Questions:

1. How is digital information stored on a CD basically?
2. What is the deal with constructive and destructive interference and the depth of pits?

Problems:

1. What is the ideal pit depth for a 405 nm blu-ray laser? (101.25 ≈ 101 nm)
2. An optical disc has a pit depth of 162.5 nm. What is the best laser wavelength to read this? (650 nm)
3. CDs use a 780 nm laser. What is the ideal pit depth? (195 nm)

**Objective G: Applying the Rayleigh Criterion to Optical Disc Readers**

Questions:

1. What is the idea behind the Rayleigh Criterion:
   1. What is angle of resolution?
   2. How does the wavelength of light used affect the angle of resolution?
   3. How does the size of the aperture affect the angle of resolution?

Problems:

1. An optical disc reader has a 3.2 mm diameter lens that is 2.0 mm from the disc. What is the smallest pit separation it can resolve if it uses 405 nm light? (3.1E-7 m or .31 μm)
2. You are designing an optical disc reader lens that must be 4.0 mm from a disc, and resolve pits that are 0.47 μm apart using 650 nm light. What must be its diameter? (6.7 mm)

**Objective H: Types of data storage**

Questions:

1. What basic types of digital storage are there?
2. What are some main differences between RAM, and the hard disc on your computer? What are the advantages of both?

**Objective I: Basic Capacitance**

Questions:

1. What is a capacitor?

Problems:

1. What is the capacitance if you can store 2.3 μC of charge at 12 V of potential? (1.9E-7 F)
2. If you have 4.8 V across a 240 micro farad capacitor, what is the charge stored? (.0012 C)
3. If you store 1.2 μC of charge on a 500. pF capacitor, what is the voltage? (2400 V)
4. A 0.130 pF CCD pixel has a voltage of 1.70 mV across it. How many electron charges does this represent? (1380 electron charges)
5. If a 0.18 pF CCD pixel is hit by 1730 photons, what is the voltage across it if it has a quantum efficiency of 100%? What if it is 70% efficient? (1.54 mV, 1.08 mV)

**Objective J: CCD devices**

Questions:

1. If the pixels on a CCD device are like capacitors, how do they get charged?
2. If CCD devices are black and white only, how are they used to create color images?
3. Why is the “magnification” in a camera really smallification? (i.e. a magnification smaller than one)

**Objective K: Calculating Random Crap with CCD Devices**

Problems:

1. A camera has a 32.0 mm by 21.3 mm sensor that has 5380 x 3580 pixels. It has a quantum efficiency of 72%. Its pixels have a capacitance of 0.14 pF.
   1. What is the area of a single pixel? (3.54E-11 m2)
   2. If each pixel has 2.30 mV across it, how many electron charges is it holding? (2010 electron charges)
   3. How many photons must have hit that area given the quantum efficiency? (2790 photons)
   4. How many photons per square meter does this represent? (7.89E13 photons/m2)
   5. If the camera used an exposure of 1/500 of a second, what is the light intensity in photons/s/m2? (3.94E16 photons/s/m2)
   6. What is the “magnification” if an image of a 67 cm tall dog eating with a knife and fork forms an image that is 17 mm tall? (0.0254x)