Name ____ Geometry

How do DVD’s work?

It's amazing when you think about it: you can store a movie several hours long on a shiny piece of plastic no bigger than your hand! Although **compact discs (CDs)** have been around for more than 30 years, they are still one of the most popular ways of storing music and computer data. In the mid-1990s, CDs evolved into digital video/versatile discs (DVDs), which look and work in a similar way but can store about seven times more. And now we have Blu-ray™, which can store six times more than a DVD—or about 40 times more a than CD! Have you ever wondered how CDs, DVDs, and Blu-rays actually work? Let's take a closer look!

Until CDs were invented, music was typically stored on plastic LP (long-playing) records and cassette tapes. LPs scratched easily, while tapes could stretch and distort and sometimes snapped or seized up entirely. Both of these ways of storing music were primitive compared to CDs. LPs were played on turntables with a moving arm that bounced along a groove in the plastic, reading back the music as it went. With the invention of CDs, people finally had a more reliable way of collecting music. CD players are neither mechanical nor magnetic but *optical*: they use flashing laser lights to record and read back information from the shiny metal discs.

In a CD, music (or other information) is stored *digitally* (as a long string of numbers). After the music has been recorded, it is converted into numbers by a process called **sampling**. Almost 50,000 times a second (44,100 to be exact), a piece of electronic equipment measures the sound, turns the measurement into a number, and stores it in binary format (as a pattern of zeros and ones). The sampling process turns a CD track lasting several minutes into a string of millions of zeros and ones. This is the information stored on your CD. In other words, there is no music on a CD at all—just a huge long list of numbers.

CDs are made from an original "master" disc. The master is "burned" with a laser beam that etches bumps (called **pits**) into its surface. A bump represents the number zero, so every time the laser burns a bump into the disc, a zero is stored there. The lack of a bump (which is a flat, unburned area on the disc, called a **land**) represents the number one. Thus, the laser can store all the information sampled from the original track of music by burning some areas (to represent zeros) and leaving other areas unburned (to represent ones). Although you can't see it, the disc holds this information in a tight, continuous spiral of about 3-5 billion pits.

So what's going on in your CD player when the disc spins around?

1. Inside your CD player, there is a miniature laser beam (called a *semiconductor diode laser*.) and a small photoelectric cell (an electronic light detector). When you press play, an electric motor makes the disc rotate at high speed (up to 500rpm). The laser beam switches on and scans along a track, with the photocell, from the center of the CD to the outside (in the opposite way to an LP record). The motor slows the disc down gradually as the laser/photocell scans from the center to the outside of the disc (as the track number increases, in other words). Otherwise, as the distance from the center increased, the actual surface of the disk would be moving faster and faster past the laser and photocell, so there would be more and more information to be read in the same amount of time.
2. The laser (red) flashes up onto the shiny (under) side of the CD, bouncing off the pattern of pits (bumps) and lands (flat areas) on the disc. The lands reflect the laser light straight back, while the pits scatter the light.
3. Every time the light reflects back, the photocell (blue) detects it, realizes it's seen a land, and sends a burst of electric current to an electronic circuit (green) that generates the number one. When the light fails to reflect back, the photocell realizes there is no land there and doesn't register anything, so the electronic circuit generates the number zero. Thus the scanning laser and electronic circuit gradually recreates the pattern of zeros and ones (binary digits) that were originally stored on the disc in the factory. Another electronic circuit in the CD player (called a digital to analog converter or DAC) decodes these binary numbers and converts them back into a changing pattern of electric currents.
4. A loudspeaker transforms the electric currents into sounds you can hear (by changing their electrical energy into sound energy).

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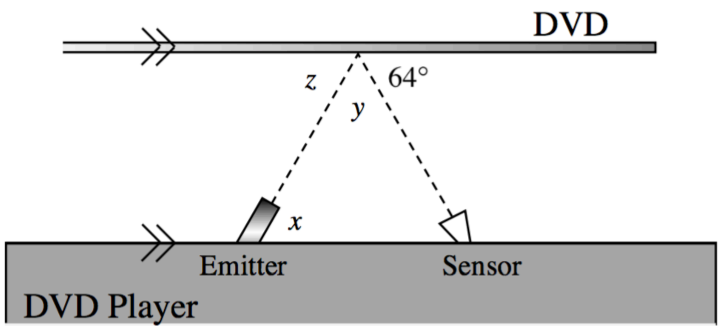

1. To read the information on the DVD, the laser must hit and bound off the DVD at a specific angle. It is essential to know that the triangle formed from the laser is an *isosceles triangle.* What ***two*** pieces of information do you need to know to determine that the triangle is in face isosceles?

2. Based on the facts you stated above, is an isosceles triangle symmetrical? Justify your answer.

3. The laser is supposed to bounce off the DVD at a 64° angle as shown in the diagram above. For the laser to go directly into the sensor, at what angle does the emitter need to send the laser beam? In other words, what does the measure of angle x have to be? Justify your conclusion with viable arguments.

4. The diagram above shows two parts of the laser beam: the one coming out of the emitter and the one that has bounced off the DVD. What is the angle ($\angle y$) between these beams? How do you know?