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Thermodynamics, Wave Motion and Optics (PHYS201)
Participation 5

Back in 1877, Thomas Edison opened the gate for manufacturing sound record by inventing a phonogram that uses sound to etches grooves onto a wax cylinder. The old phonogram spins at 33 1/3 rpm (rotations per min). Suppose, you are asked to examine the diffraction grating effect by shining laser light onto the record as shown the figure. If the laser light is of $\lambda = 632.8$ nm, you put the screen at a distance of 4 m away from the record and you observed an interesting red dot on the screen separated by 21 mm each, as illustrated.

1. Deduce the number of ridges per centimeter there are along the radius of the record.

$$\lambda = d \sin\theta \tag{1}$$

$$d = \frac{\lambda}{\sin\theta} = \frac{\lambda}{\sin\left(\tan^{-1}\left(\frac{x}{L}\right)\right)} \tag{2}$$

$$= \frac{632.8 \times 10^{-9}}{\sin\left(\tan^{-1}\left(\frac{21\times10^{3}}{4.0}\right)\right)} \tag{3}$$

$$= 1.2 \times 10^{-2} \tag{4}$$

$$\frac{1}{d} = \frac{1}{1.2 \times 10^{-2}} = 83\text{ridges/cm.} \tag{5}$$

2. If you know that the record has only one song of 4.01 minutes and occupy 16 mm on the record. In such case, deduce the number of ridges there are per cm.

$$4.01 \times 33.3 = 134 \tag{6}$$

$$\frac{134}{1.6} = 84\text{ridges/cm.} \tag{7}$$