42. a)

$$S_1S_2 = 2.5\ cm = 0.025\ m$$
$$PS_1 = 4.9\ cm = 0.049\ m$$
$$PS_2 = 6.6\ cm = 0.066\ m$$
$$\lambda = \frac{|PS_1 - PS_2|}{n - \frac{1}{2}} = \frac{|0.049\ m - 0.066\ m|}{3 - 0.5} = 0.0068\ m \cong 0.007\ m$$

The wavelength of the waves is 0.007 metres. The distance between the sources is 0.025 metres. The path difference from the first source is 0.049 metres and the second source is 0.066 metres.

b)

$$P_bS_1 = 0.062\ m$$
$$P_bS_2 = 0.058\ m$$
$$\lambda = \frac{|P_bS_1 - P_bS_2|}{m} = \frac{|0.058\ m - 0.062\ m|}{1} = 0.004\ m$$

From choosing a point on an antinodal line, the wavelength was calculated to be 0.004 metres.

Answer in b) should be close to that in a)

Please, review

c) Having the frequency increase on the interference pattern would have the effect of increasing the wavelength or decreasing the velocity. This is because frequency is related to velocity and wavelength by $f = \frac{v}{\lambda}$.

d) Increasing the distance between the wave sources would an effect on the wave interference pattern by lowering the wavelength and the amount of nodal/antinodal lines. This is because the change in distance is proportional to the amount of nodal/anitnodal lines and the wavelength; $\frac{\Delta P_n S}{\lambda} = \left(n - \frac{1}{2}\right)$ or $\frac{\Delta PS}{\lambda} = m$.

e) If the vibrating sources were changed so that they were vibrating completely out of phase, the effect that this would have on the interference pattern will be that the wavelength will have either a value of zero or the amount of nodal/antinodal lines would be zero.

8/9

43. For music to travel a greater distance, it would require a greater amount of energy. That energy would be related to an increase in velocity, which can be described as $v = f\lambda$. As the velocity decreases as the energy lowers, the wavelength lowers since the frequency must stay constant. For there to be a

lot of kinetic energy for the sound to travel a large amount of distance, then the frequency would have to be high. Therefore, you would most likely hear the treble (high frequency sounds) rather than the bass (low frequency sounds).

Most likely to hear the bass notes. Low frequency, longer wavelengths, diffract more, bend more around barriers.

0/ 3

44. "Being wired" to technology has affected my life quite a lot. It has affected the way I interact with society by how I go about making money. Most teenagers are on social media sites, such as Facebook, Twitter, and Tumblr, while I have exercised my resources more towards an entrepreneurial use. I tend to use LinkedIn, Elance, and Github to maximize the advertising and development of my web programming. When it comes to "being wired", I am one of the people who make a small living off of being a "wired being".

I think that technological progress has been for the better when it is within the open-source community. For example, Microsoft's CEO, Steve Ballmer, has, as some people may argue, taken Microsoft in a negative direction (Girard, 2013). In late 2012, Microsoft was literally developing technology that had surpassed Apple, but due to management (read: Ballmer), trashed it as he felt it would decrease Office and Windows sales. This would not have happened if Microsoft would have open-sourced their technology like Google has, to whom are in competition and losing their Office sales due to Google's Google Drive. It can then be implied that technology in a whole is progressing, as companies that utilize open-sourcing are earning a greater audience (such as Google), while companies that charge are earning less sales (such as Microsoft).

5/5

45. The educational path that could be followed to get a job with the Canada Digital Systems Inc. as a Production Support Technician may be to get a Diploma as a Photonics Engineering Technician from Niagara College. This program runs for two years or four semesters and is the fastest of the photonics programs that Niagara College offers (Niagara College Canada, 2012). If one were to go further in their education and be more competitive, then they could take the Photonics Engineering Technology program and thereafter the Advanced Lasers graduate program (Niagara College Canada, 2012). The Photonics Engineering Technician program would cost $2526.42 for Tuition, $552.20 for SAC Fees, and $971.20 for Ancillary Fees (Niagara College Canada, 2012). In total, the program will cost $4049.82 per semester or $16199.28 for the full two years or four semesters.

6/6

46. a) A pattern of bright and dark fringe are visible on a screen when a light is shone through because there is Light Interference. The bright and dark fringes occur because some light waves will land on the screen in phase (bright fringes), while others will land on the screen out of phase (dark fringes).

The constructive and deconstructive patterns that cause the light to land on the screen in-phase and out-of-phase are caused by the Light Interference.

- If the light from two sources happens to arrive at the screen in phase b/c their path difference differs by some multiple of λ, constructive interference occurs, causing a bright fringe
- If the rays are out of phase, b/c the path difference involves a 0.5λ. destructive interference occurs, creating a nodal or dark area.

b)

$$d = 2.5\times10^{-4}\ m$$
$$L = 3.02\ m$$
$$\Delta x = \frac{2.95\times10^{-2}\ m}{3.5} \cong 8.423\times10^{-3}\ m$$
$$\sin(1.12°) = 7\frac{\lambda}{2.5\times10^{-4}\ m}$$

Method 1:

$$\sin(1.12°) = 7\frac{\lambda}{2.5\times10^{-4}\ m}$$
$$\lambda = 6.98\times10^{-7}\ m$$

Method 2:

$$\Delta x = 8.423\times10^{-3}\ m = \frac{(3.02\ m)\lambda}{2.5\times10^{-4}\ m}$$
$$\lambda = 6.98\times10^{-7}\ m$$

Method 3:

$$\frac{x_n}{L} = \frac{2.95\times10^{-2}\ m}{3.02\ m} = \frac{(3.5)\lambda}{2.5\times10^{-4}\ m}$$
$$\lambda = 6.98\times10^{-7}\ m$$

The wavelength of the light being used is 0.698 µm.

8/ 10

47. a)

Method 1:

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

To lower the distance between the fringes, one would have to see a reduction in θ. To lower θ, one would have to either decrease the wavelength or increase the distance between the slits.

Method 2:

$$\frac{x_m}{L} = \frac{m\lambda}{d}$$

To lower the distance between the fringes, one would have to see a reduction in $\frac{x_m}{m}$. To lower $\frac{x_m}{m}$, one would have to decrease the distance from the slits to the screen, decrease the wavelength, or increase the distance between the slits.

b) Safety precautions one would take would be to wear laser radiation protection goggles in case the laser is shined into ones eye, and make sure the laser is not directed towards any mirrors that may be directed towards ones eye level. The sources of error that one might encounter include the distance measurement of the slits and screen, the angle to which the laser is shone, and the distance of the change in distance for a fringe.

5/ 5

48. The laser is related to the physics of light and waves because it is Light being Amplified through the Stimulated Emission of Radiation; or LASER. The laser functions by sending out a beam of light towards air particles. The air particles then become excited by the light and re-emit it back out into the air where the light then hits the eyes and the beam is then seen. The laser is used throughout our daily lives: from reading CD/DVDs to pointing out celestial objects in the sky. Its link in science ranges extensively, from cancer and eye surgeries to exciting sub-atomic particles to researching theories in the fields of physics, chemistry, and biology; such as testing theories of quantum electrodynamics, constructing single-walled carbon nanotubes, or developing new treatments from biomedical research. The laser utilizes light as its primary resource, which is used throughout our daily lives and science.

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49. a)

$$\lambda = 5.6 \times 10^{-7}\ m$$
$$L = 3\ m$$
$$\Delta y = 5(2.5) \times 10^{-2}\ m$$

$w = \frac{L\lambda}{\Delta y} = \frac{(3\ m)(5.6\times10^{-7}\ m)}{5\times10^{-2}\ m} = 3.36\times10^{-5}\ m$ please, review value of Δy

The width of the slit is $3.36\times10^{-5}\ m.$

$$m = 1$$

$$y_m = \frac{(m+1)L\lambda}{w} = \frac{2(3\ m)(5.6\times10^{-7}\ m)}{3.36\times10^{-5}\ m} = 0.1\ m$$

The distance between the adjacent maxima to the central maximum is $0.1\ m$.

b) i) If the width of the slit was smaller, the effect that it will have on the pattern will make the fringes larger and brighter since w is inversely proportional to Δy and w is decreasing; therefore Δy must increase.

ii) If the screen was moved further away, the effect that it will have on the pattern will make the fringes larger and brighter since L is proportional to Δy and L is increasing; therefore Δy must increase.

iii) If a larger wavelength was used, the effect that that will have on the pattern will make the fringes larger and brighter since λ is proportional to Δy and λ is increasing; therefore Δy must increase.

c) i) If the light were shone through a double slit, the interference pattern would differ in the fringes so that there will be "two" central maximums and that the farther away a bright fringe is, the darker a bright fringe will appear.

ii) If the light were shone through a diffraction grating, the interference pattern would differ in the fringes in that the pattern of fringes will appear narrower, brighter, and sharper. The greater the line density, the more narrow the fringes will appear.

8/ 10

50.

$$\lambda = 5.6\times10^{-7}\ m$$
$$w = \frac{10^{-2}\ m}{1500}$$
$$L = 1.5\ m$$
$$\frac{y_m}{L} = \frac{(m+1)\lambda}{w}$$
$$\frac{y_m}{m+1} = \frac{L\lambda}{w} = \frac{(1.5\ m)(7.6\times10^{-7}\ m)(1.5\times10^{-2})}{10^{-2}\ m} = 1.71\times10^{-1}\ m$$

The distance between the adjacent bright fringes is 0.171 metres.

4/4

51. Lenses contain thin coatings to reduce UV radiation by causing a deconstructive ?? interference when light enters the film. The film causes a light wave of UV radiation to disperse into two waves. One will be slowed down more as it goes through the film just enough so that is deconstructive destructive interference with the second UV wave. This will cause the UV rays to have a lower amount of amplitude in its crests and troughs, thereby making the UV radiation have less potential energy to harm the eye.

4/4

52. The effect of rotating two polarizing films, with respect to one another, will create a pattern so that the light will initially be vertical if the two filters are initially set for it to vertical. As the two plates rotate, and if the rotate in the same direction since their direction is in respect to each other (see Figure 1), one will see that the light will be polarized at the angle in which the plates have rotated. As the plates move around, one will see the vertically polarized light (at the 12 o'clock position), then the horizontal (at the 3 o'clock position), vertical (at the 6 o'clock position), horizontal (at the 9 o'clock position), and finally the vertical (at the 12 o'clock position) as the two plates make a complete revolution.

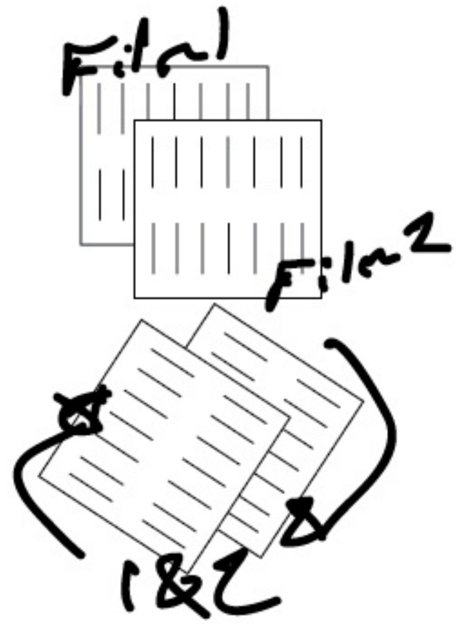

Figure 1: The Direction of Rotation in the Polarizing Films
Image Credit: Ben A. Morgan

Refer to light as being a transverse wave

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53. a) Oscillators create waves by rapidly changing a current through connecting and disconnecting a charged capacitor (which is made up of two metal plates surrounded by a non-conducting material) and inductor. The changing current is kept at a single frequency; known as the carrier frequency. The capacitor stores energy in the form of an electrostatic field, while the inductor stores energy stores the energy in a magnetic field. When a capacitor is placed in the same circuit as an inductor, the capacitor will discharge through the inductor. After the discharge, the inductor will have a magnetic field because it tries to maintain the current that is being created. When the inductors magnetic field collapses, the capacitor will be recharged, where the capacitor will then have a negative charge. Again the capacitor will discharge and the process repeats, creating an oscillating current whose frequency is dependent on the size of the capacitor and the inductor.

b) The possible side effects of using cell phone usage were examined through the effects of acoustic neuroma, brain tumors, and semen quality. Stefan, Anders, Per, and Maria (2004) found that acoustic neuroma to have no relation to short-term mobile phone use, while their data did suggest that acoustic neuorma may be associated with long-term mobile phone use of at least 10 years. Khurana et al. (2009) also found that after ten years there is a risk from cell phone usage through analyzing brain tumors on the same side of the brain that cell phones are used. On sperm quality, cell phones were also related to the proportion of rapid progressive motile sperm with low transmitter groups having 48.7% and high transmitter groups having 40.6% (Fejes, et al., 2005). In my opinion from what I have learned, my cell phone use will not be moderated since the studies have shown a non-significant relation to cell phone use compared to acoustic neuroma, brain tumors, and semen quality.

11/11

54. The Technology of the Year Award for 2003 goes to the DVD. The DVD is now the primary use of storing data for the home theater and running software applications on computers. The DVD is presented with a brief history, how they are made, the different types of DVDs, and their further development.

It was in 1994 that SONY and Phillips partnered together to create medium, called the Digital Video Disk (DVD) (OpenCloner Inc., n.d.). The DVD was the first successor to the compact disk (CD-ROM) and the VHS tapes. The data capacity for the DVD was about 10 times that of the CD-ROM, making it a very attractive technology. The DVD-Video format was released to Japan first, then the United States in 1997, and finally Europe, Australia, and Brazil in 1998. In May 1997, the DVD Consortium was changed to the DVD Forum, which allowed companies to be able to participate in the development of the DVD.

DVDs are made of multiple layers and system information that allow it to work. The information is encoded onto a DVD by using a form of small pits and bumps in the track of the disc (see Figure 2). The layers of a DVD are about 1.2 mm in thickness of polycarbonate, and then a thin reflective layer is then sprayed onto the disc to cover the bumps. Aluminum is used behind the inner layers and gold is used on the outer layers as to allow a laser that will be reading it to be able to focus through the outer and inner layers. After all the layers are made, lacquer is coated is coated onto each layer and then squeezed together using infrared light to cure them. There is a spiral track that a laser must follow in order to read the DVD. This starts from the inside, moves to the outside, and is only 740 nm in width. The elongated bumps are about 320 nm in width. (Alleman, n.d.) The multiple layers and how the size of the bumps and tracks allow for the DVD to be host to so much information is one reason it is the Technology of the Year for 2003.

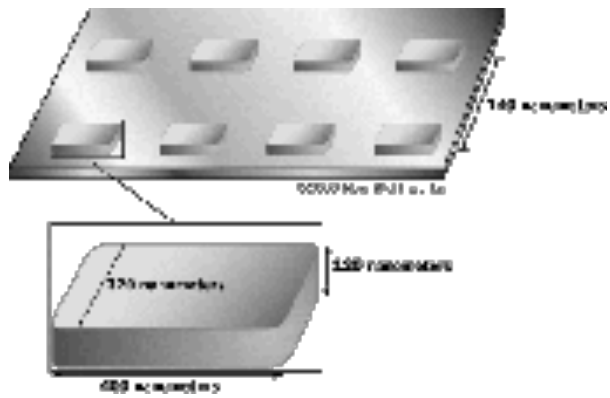

Figure 2: The Bumps/Pits of a DVD
Image Credit: HowStuffWorks.com

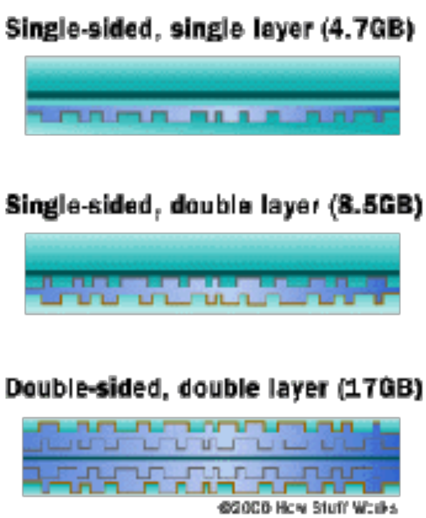

Figure 3: The Formats of a DVD
Image Credit: HowStuffWorks.com

There are three main differences between DVDS: the amount of readable sides, the amount of layers, and the system format. The amount of layers in a DVD tells one how much data can be stored inside of it. The amount of readable sides allows a person to place the DVD on either side, but this also nearly doubles the amount of information that there is in the DVD (see Figure 3); a single-sided/single-layered DVD holds 4.38 GB while a double-sided/single-layered DVD can store 8.75 GB. The amount of layers is also a variable, with the more layers, the more information that can be stored within the DVD (see Figure 3); a single-sided/double-layer can store 7.95

GB and a double-sided/double-layered DVD can store 15.9 GB. Japanese and American television use the NTSC video format so that when movies are released, they are presented in 30 frames per second and in a sequence of 60 fields, which contains alternating lines of the picture. There is also the PAL system which displays at 50 fields per second in other countries. The large breadth of side readability, layering, and system formatting gives the DVD another reason it is the Technology of Year for 2003.

Future developments of the DVD include HD DVDs and Blu Ray discs. HD DVDs work by compressing the video more effectively, using lasers at 405 nm rather than 650 nm, and the bumps or pits are smaller and loser together (Wilson, n.d.). Blu Ray discs work by holding the information only 0.1 mm under the surface of the polycarbonate so that a 405 nm laser and a high-numerical-aperture lens are able to read over five times more information than the standard DVD (Perenson, 2006). For the fact that the DVD is able bring truly high resolution video and audio to the home theater, it is for one of these reasons that the DVD was selected for the Technology of the Year Award for 2003.

From the developmental history, the ingenuity of its creation, and the breadth of its data storage, it is for this reason that the DVD is awarded the Technology of the Year Award for 2003. Future developments look at HD DVDs and Blu Ray Discs to which will make the home theater even more wholesome than they already are.

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Marks Earned = 90

Total = 99

Final = 90/ 99 = 91%