Theory study on electromagnets and electromagnetic therapy biology essay

Science, Biology

This research is going to be divided into two main sections where the first section is an introduction to the electromagnetic concept featuring the history of electromagnetism, some details regarding electromagnets such as various applications where these are used and finally high field electromagnets would be considered. The second section describes different techniques where electromagnetic fields are used in certain health issues. Section 1The word electromagnetism is made up of two Greek words, ‘ amber’ and ‘ magnet’. This phenomenon of electromagnetic force is sometimes also referred to as the Lorentz force and comprises both electricity and magnetism as basics of one phenomenon. As science shows, there are in total four essential relations in nature one of which being electromagnetic force. The other three include strong interaction, weak interaction and gravitation. Electromagnetic forces, most of the times are described via electromagnetic fields where many physical cases occur such as the interaction of electrically charged particles and also the interaction of uncharged magnetic force fields with electrical conductors. Several different mathematical equations have been derived to explain electromagnetic fields. Electric field is defined as electric potential and electric current in Ohm’s Law, magnetic fields are related to electromagnetic induction and magnetism in general whilst Maxwell’s equation describes how electric and magnetic fields are produced and may be changed by each other as well as by charges and currents. The introduction to the special relativity by Albert Einstein in the early 1900’s was due to the theoretical suggestions of electromagnetism where the formation of the speed of light based upon properties of the ‘ medium’ of propagation took place. Electricity and

magnetism in general were thought to be two different forces however, James Maxwell in 1873 managed to publish " Treatise on Electricity and Magnetism" which helped to change this concept. In this publication, the relations of positive and negative charges were shown to be controlled by one single force. Four main concepts have emerged from this study which were all confirmed through experiments. These include: Electric charges attract and repel each other with a force that is inversely proportional to the square distance between the two. Basically this rule is simplified to like charges repel, unlike charges attract. Similar to electric charges, magnetic poles can either attract each other or repel each other and they also come in pairs. North poles are attracted to south poles but are repelled by another north pole. Having a loop of wire, a current may be induced by either moving the wire towards and away from the magnetic field or else by moving the magnet towards and away from it. If a current is passed through a wire, a circular magnetic field is generated around that wire. The direction of that field, either clockwise or anti-clockwise, can be found by using the right hand grip rule. http://upload. wikimedia. org/wikipedia/commons/thumb/9/91/Electromagnetism. svg/220px-Electromagnetism. svg. pngIt was also observed by Hans Christian Ørsted in 1820, that a compass needle deflected from magnetic north pole when an electric current generated from a battery was repeatedly switched on and off. From this observation a conclusion was drawn that a magnetic field radiates from all the sides of a piece of wire carrying current similarly to way light and heat are radiated. Thus, a direct relationship was created between magnetism and electricity. During the 19th century further developments

and studies showed that different frequencies of oscillations can generate different forms of electromagnetic radiation. These vary from radio waves to the visible light and gamma rays ranging from very low frequencies up to very high frequencies respectively. James MaxwellHans Christian ØrstedAn electromagnet with ferromagnetic coreStudying into more detail the concept of electromagnetism, first the electromagnet will be considered. This is a type of magnet where the magnetic field is being generated by the flow of electric current. It is generated only when the current is passing through the wire; if no current is passing the magnetic field dies. These magnets are widely used in different equipment including motors, generators, relays, loudspeakers, hard disks, different scientific instruments, magnetic separation equipment as well as in situations where heavy iron objects must be moved, thus electromagnets are used to lift such items. As already mentioned, a wire looped into a coil with current passing through generated a magnetic field. To make the field even stronger, turns of wire must be increased or else the thickness of the wire must be increased. The strongest magnetic field is found at the center of the coil. Introducing a ferromagnetic material at the core of the coil, such as soft iron, would make the magnetic field even stronger by thousands of times due to high magnetic permeability of the material inside the core. An example of such electromagnet is shown in the picture above. Magnetic field produced by a solenoidThe main advantage of such magnets is that the strength of such fields may be controlled by varying the amount of current passing through the wire. However, a constant supply of electrical energy must be generated to maintain the field. As mentioned earlier, several applications and equipment

nowadays require an electromagnet to be able to function properly. Such devices include: Motors and generatorsRelaysActuatorsTransformersMagnetic locksBells (electric)LoudspeakersData storage equipment including tape recorders and hard disksParticle acceleratorsMagnetic separation equipmentLifting magnets for industrial useElectromagnetic suspensionA more detailed description of specific applications where electromagnetism is used follows in the next paragraph. Electromagnetism has various uses in the every day to day life such as in homes, in technology such as computer hardware and memory devices, power circuits and communication devices, scrap yards, etc. Starting from home appliances, many of our electrical home appliances make use of electromagnetism as a basic principle of working. Taking the electric fan as an example, the motor at the back works on the principle of electromagnetic induction which helps to keep the motor rotating therefore making the blade on the front rotate. An electric doorbell works on the same principle. When the button is pushed, the coil inside the bell gets energized and due to electromagnetic forces, the bell rings. A loudspeaker used in many different applications, produces sound due to the movement of the coil being under an electromagnetic force. There also exist magnetic locking devices used to secure homes and bank safes where a number secret code or else a magnetic card are used. In the latter case, the secret code is stored in the magnetic tape at the back of the card, and when this is swiped and the number match those numbers stored in the memory of the magnetic card reader beside the door, this is unlocked. Storing data nowadays is done in the form of bits and bytes on many devices such as USB sticks. Computers

too have hardware including magnetic tapes working by using the electromagnetic principle. In order to display images on the screen, computers and televisions make use of high current electromagnets in order to produce a beam of electrons from the cathode ray tube. Important to note that older VCR’s and VCP’s used rolls of magnetic tapes which could only be read via electromagnetic means only. Telephones and nowadays mobiles also make use of electromagnetism in order to make calls over large distances where basically, interactions between signals and electromagnetic pulses take place. Relays used in power devices, which are basically used to cut down large current to a certain load by using small currents, also make use of electromagnetism in their principle. A small magnetic coil could be energized and when it is, it is able to break the contacts. As will be discussed later on in section 2 of this report, electromagnetic fields are widely used in health applications such as MRI scans. This device is able to scan the human body in a few minutes where it uses the principle of electromagnetism to work. Last but not least, electromagnetism is also used in transport nowadays. Modern day fast trains situated mainly in Japan and Germany, depend on the electromagnetic principle too to be able to operate. Important to mention that these electromagnets have several side effects associated with them. Ohmic heating is one such side effect. As many other devices, the resistance provided by the windings of such electromagnets is dissipated as heat at some point or another. Having large electromagnets would require some sort of cooling systems such as water circulating through pipes in the windings. Varying the number of turns in the windings and the current would result in different heat dissipation, and therefore calculations may be

performed in order to design such electromagnet which would dissipate less heat. P= I2R, therefore the power dissipation increases with the square of the current. This however increases almost linearly with the number of windings, so in order to minimize heat losses, one may half the current and double the number of windings. One drawback of this in practice is that increasing the number of windings means that more room space must be made available to such electromagnets. It is possible to reduce the thickness of the wire that is decreasing the diameter but this this would result in higher resistance, therefore more heat dissipation, thus no problem would be solved at this point. This therefore leads to the fact that there is a limit to how much the heat dissipation from electromagnets can be reduced. Another side effect present is the inductive voltage spike. An electromagnet can also be considered as an inductor and therefore resists the change of current from one direction to another through its windings. Voltage spikes take place across these windings when there is a sudden change in electric current. This is due to the fact that energy must be stored in the magnetic field from the circuit at the instant when the current is switched on or is increased and reversely must be stored in the circuit once the current is switched off. Using a switch to control the current through the windings can cause the mentioned voltage spikes at the terminals. Once this switch is off, as mentioned earlier, energy in the magnetic field is allocated back to the circuit causing voltage spikes and an arc across the contacts of the switch which might cause damage. In order to eliminate this problem, for small electromagnets a capacitor is included across the contacts of the switch which basically stores the current temporarily, therefore eliminating the arc.

In addition to this, a diode may be included so as to direct current in only one direction, through the same windings of the electromagnet, so that eventually this current circulates through the windings until energy is lost as heat. It must be made sure that the orientation of such diode is in reverse-bias during normal operation and in forward-bias when current is switched off so that the voltage spike created directs the current through the windings and then to the diode back to the winding. A diode connected in such a manner is called a flyback diode. For larger scale electromagnets, these are normally driven by a variable electronic power supplies which are controlled via microcontrollers thus eliminating the voltage spikes from occurring by changing currents slowly. Lorentz forces are another form of drawbacks these electromagnets have. Electromagnets which are quite powerful generate a magnetic field which uses a force on each and every turn of the windings due to Lorentz force, which is acting on the moving charges through the wire. Lorentz force can be observed below: This force is perpendicular to both the axis of the wire and also of the magnetic field. One may look at it as a pressure between magnetic field lines which is trying to push them apart. Two effects imposed on the electromagnet’s windings are: The field lines within the axis of the electromagnetic coil employ a radial force on every turn of the windings which results in them being pushed apart. This results in the wire having tensile stress. The other effect is the leakage field lines between every turn of the coil apply a repulsive force between turns which again results in these turns to be pushed apart. Lorentz force increases with the square of tesla, B. It is of vital importance in large electromagnets that the windings be firmly held in place in order to prevent

movement during power-up and power-down. Last but not least, the final drawback considered is the core losses. Magnetic fields of AC electromagnets are changing constantly, where such magnets are used in transformers, inductors, AC motors and AC generators. This gives rise to losses in the core which is dissipated as heat. These losses are generated from: Eddy currentsHysteresis lossesEddy currents are those currents induced in conductors due to the changing magnetic field. These currents are in closed loop flow where current is perpendicular to the magnetic field. The energy caused by this current is dissipated as heat due to the electrical resistance of the conductor and is proportional to the area bounded by the loop. Thus, electromagnets with ferromagnetic core, which is conductive, suffer from this problem of eddy currents. To be able to prevent this problem, cores of such electromagnets are made up of laminations of steel sheets, which are quite thin, parallel to the magnetic field having an insulating coating all over the surface. This prevents eddy currents from flowing between the sheets. Another method which may be used to resolve this problem is to use a ferrite core instead of a ferromagnetic core since it is not conductive. Hysteresis losses are caused by reversing the direction of magnetization of the magnetic domains inside the core material where each cycle causes energy losses. The area inside the hysteresis loop represents the energy lost per cycle. A method to reduce such losses is to use soft low coercivity materials as magnetic cores, such as silicon steel. Coercivity refers to the intensity of the applied magnetic field required to minimize the magnetization of the respective material to zero. In the next section, high field electromagnets will be considered. Three main types that exist are the

superconducting electromagnets, Bitter electromagnets and exploding electromagnets. For the first type, superconducting electromagnets are used in cases where magnetic fields higher than the ferromagnetic limit of approximately 1. 6 tesla are required. They are typically used in accelerators, for research and in MRI equipment. As mentioned earlier, smaller electromagnets use ferromagnetic material but in this case, superconducting windings, which are cooled with liquid helium, are used. These electromagnets allow very high currents to flow which in turn are able to create very high magnetic fields. As all other electromagnets, these too suffer from some sort of limitation which is the field strength at which the winding material stops to be superconducting. The main drawback of these superconductors is that they require certain refrigeration equipment which is quite expensive. This can minimized by lower the operating costs since these electromagnets do not require any power after start up due to the fact that no energy is dissipated as heat. Bitter electromagnets, designed by Francis Bitter around 1933 differ from the superconducting electromagnets in the design of their core, since these are made of air core which is non-superconducting. These Bitter electromagnets do not consist of wire windings but instead are made of stacks of conducting discs in the form of a solenoid, which are arranged in such a manner that the current flows in a helical path throughout. As mentioned earlier, Lorentz force of a field increase with the square of tesla, B2, and these Bitter electromagnets are designed to have enough mechanical strength to withstand such forces. In order to minimize heat losses, the discs contain holes through which water may pass therefore carrying away any heat dissipated. The last type of high

field electromagnets considered is the exploding electromagnet. Due to the fact that it is sometimes quite difficult to dissipate all the heat generated by electromagnets, a technique where brief pulses of current are sent has been adopted. These explosive electromagnets use explosives in order to compress the magnetic field inside the electromagnet as it is being pulsed. This implosion compresses the electromagnet’s magnetic field to values of B ranging up to 1000T for a very small period of time, s. One may think that this technique is quite dangerous however there exist methods which control the explosion in a way that both the experiment and the magnetic structure are not destroyed by forcing the direction of the explosion radially outwards. Such electromagnets are also referred to as destructive pulse electromagnets. The main applications where these are quite useful are in physical and materialistic science research in order to study the properties of material at very high magnetic fields. Section 2Starting with a brief history behind electromagnetism in health issues, the effect of magnetism and energy forces have been studied since the times during Greek and also Roman empires. In more modern times, the discovery of electricity brought with it the discovery of electromagnetic treatments. Going back to the mid-1800s, a large number of electronic machines have been applied to a long list of illnesses, though not all devices have been proved to be effective. In certain cases, the result of such devices was the total opposite of what was expected where serious injuries and even deaths have resulted. On the other hand, there is equipment which managed to become a backbone of modern medical practice where one may mention x-ray machines, radiation therapy, magnetic resonance imaging, more known as MRI, and also heart

pacemakers. During the late 1800s, Albert Abrams managed to develop certain devices which he claimed are able to detect the frequencies of diseased tissue and could ten heal the underlying imbalances. The idea of having diseases being diagnosed and healed by radio-like frequencies is also referred to as radionics. However, Abrams and his team never managed to prove that his devices were effective. It wasn’t only Abrams who came up with different devices which he claimed are able to heal certain diseases but there also exist other equipment such as the BioResonance Tumor Therapy, the Cell Com system, the Rife machine and also the zapping machine which are yet not proven scientifically to be fully functional. These will be described later on. Basically, electromagnetic therapy involved the use of electromagnetic energy in order to diagnose or else treat a disease. Other medicine providers might offer low-voltage electricity, magnetic fields, radio waves and other types of electromagnetic energy which is generated by electric current for this main purpose. When speaking of electromagnetic energy, the electromagnetic spectrum should be considered, which is displayed below. This energy is made up of electricity, microwaves, radio waves, ionizing radiation, infrared rays and also magnetic fields generated by electricity. Light may also be considered part of this spectrum, however, is not part of the electromagnetic therapy but is considered as a separate form of therapy, Light therapy. http://mynasadata. larc. nasa. gov/images/EM_Spectrum3-new. jpgThere is a long list of devices which fall under this category of electromagnetic therapy. In general, those who make use of such therapy claim that when electromagnetic frequencies or else energy fields within the human body become out of balance, that is when

illnesses and diseases occur. It is said that these imbalances upset the body’s chemical makeup. Thus, by applying electromagnetic energy from outside the body by using electromagnetic devices, experts say that these imbalances can then be corrected. Some illnesses and diseases which are said to be curable via electromagnetic therapy are ulcers, headaches, burns, chronic pain, nerve disorder, spinal cord injuries, diabetes, gum infections, asthma, bronchitis, arthritis, cerebral palsy, heart disease and also cancer. The four main devices used in electromagnetic therapy, which are still very widely used till these days are listed below. The BioResonance Tumor Therapy was the idea of Martin Keymer who claimed that the therapy is rooted in the age-old idea that it is possible to tap into the vital energy which flows throughout the human body. It is said that a small electronic device is used to cause vibrations which in turn energize the p53 gene in order to cure cancer. Experts claim that the BioResonance Tumor Therapy cures around 80% of the cases even though no precise description is given as to how this is supposed to happen. This treatment can take up to approximately 6 weeks. The Cell Com system was invented by Hugo Nielsen and he claims that this system us able to increase the communication between cells. This basically is said to transmit low-voltage electricity through electrodes which are placed on the hands and feet in order to be able to initiate communication between cells throughout the body. It is used to relieve pain caused by cancer and also is used to fight asthma, bronchitis and arthritis. Royal Raymond Rife was the creator of the Rife machine, also known as the Rife frequency generator. Rife declared that the cancer originated from bacteria, and he claimed that the Rife machine emitted radio waves at the

same frequency as those discharged by the bacteria, which in turn created vibrations causing the bacteria to be destroyed. Experts claim that this machine is able to destroy microorganisms that cause disease. This machine is used to direct electrical impulses at the feet to break up the supposed accumulated deposits of toxins at the nerve endings. Throughout the treatment, the patient should place their feet in a plastic box which is in turn attached to the Rife machine. Last but not least, the zapping machine has been used mainly to treat patients suffering from AIDS, cancer and certain other diseases. This machine is basically a small battery-powered device which produces low-frequency electrical current. The electricity is then transmitted to the patients via wires connected to copper tubes. The zapping machine is said to be able to kill the parasites that cause cancer. Science has been able to establish the fact that electrical and magnetic energy does in fact exist in the human body. Certain devices include EEGs in order to measure the electrical activity inside the human brain and also EKGs in order to measure electrical patterns of heartbeats. Defibrillation is a method used in order to start the heart where electrical energy in this case is used. As already mentioned, devices such as the electroencephalogram, known as EEG, electrocardiogram, known as EKG, magnetic resonance imaging, known as MRI and also transcutaneous electrical nerve stimulation units, known as TENS, are all approved for medical use. These are basically used to diagnose heart problems and sometimes also physical problems. TENS system is used to reduce the pain by interfering with the nerve conduction of pain impulses. In addition to this, certain electromagnetic energy has been medically approved in order to be used in cancer treatment. Such electromagnetic

energy includes X-rays, radiation therapy, radio-frequency ablation as well as microwave ablation, used to destroy tumors. It is quite important that special equipment is used to generate such waves and high-energy electromagnetic fields which could be then focused on the area being treated. Some arguments state that low level radio waves are not strong enough to be able to produce a significant effect on the body and there is no such evidence which proves that electromagnetic energy produced by such devices and equipment is in fact destroying bacteria and other living cells. Taking for example the BioResonance Tumor Therapy device, it is known to be true that the p53 gene does not behave properly in most cancerous tissues; however, no study shows that this gene can be energized by using some sort of electromagnetism. On the other hand, high-energy radio waves can be used to, in a way, ‘ cook’ cancer cells through a process referred to as radiofrequency ablation. Microwaves are also used to heat and destroy tumor cells. Further studies show that powerful electromagnetic fields are able to change the responses of some of the body’s cells. In addition to this, there are also claims that say these electromagnetic fields may be used to help fractured bones however further studies are required in this field. Another study which still requires further details and confirmations is that pulsed electromagnetic stimulation may be able to reduce frequency of migraine headaches. It has been said that electromagnetic energy may be used in cases to reduce some sort of pain, however again more thorough research is required so as to be able to approve this claim. One research which was carried out in 2010 confirmed that electromagnetic treatment was in fact not useful to treat bedsores. Other studies are being carried out in

order to be able to conclude whether electromagnetic fields might be useful in any other illnesses and to also determine whether it is possible that electromagnets may be used in conventional medicine in the future.