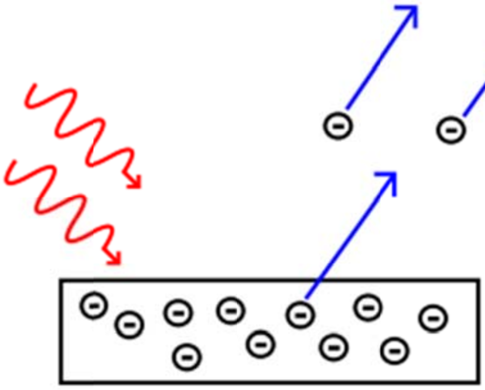
Initially, scientists thought that light was a wave for many reasons such as the ability of light waves to interfere with each other. A medium called the aether was proposed which allowed a wave model of light a medium through which to travel.

Over the years, the wave model became accepted until it was cast into doubt by the Michelson-Morley experiment which suggested that the aether did not exist. In the mid 1800's, Michael Faraday proposed that light was a high frequency electromagnetic vibration which could propagate in the absence of a medium. From Faraday's work, James Maxwell concluded that light was a form of electromagnetic radiation. Soon after, Heinrich Hertz confirmed Maxwell's theory experimentally.



The wave model successfully explains many of the optical and electromagnetic phenomena however some anomalies began to arise which contradicted or could not be explained by the wave model. Such as the photoelectric effect (first noticed by Hertz) which is the phenomenon in which electrons are emitted from matter as a consequence of their absorption of energy from electromagnetic radiation of a very short wavelength.

More anomalies arose, one of which was solved by Max Planck who developed his theory on black body radiation. He came up with the idea based on the fact that black bodies emit light a "packets" or energy called quanta. A particle of light was called a photon which has energy: $E = hf$ where h is Planck's constant.

Modern thinking of the photo electric effect has led to the theory of wave-particle duality in which light has both a particle and wave natural. It is possible to explain and prove the photo electric effect using both the wave and particle model.

http://en.wikipedia.org/wiki/Light#Wave_theory

http://en.wikipedia.org/wiki/Photoelectric_effect

The properties of cathode rays have been tested by William Crookes to investigate the properties of cathode rays. There were numerous tests that he conducted.

They are produced by the negative electrode, or cathode, in an evacuated tube, and travel towards the anode.

They travel in straight lines and cast sharp shadows.

Plucker made an anode out of a maltese cross and when he turned on the power, a shadow was produced at the other end of the tube, this proved that cathode rays travelled in a straight line.

They have energy and can do work.

Crooks placed a paddle wheel inside a discharge tube creating a virtual vacuum. The paddle wheel turned and moved from the cathode to the anode. This proved that cathode rays have energy and therefore momentum and that they might be made of particles. It also showed the direction of the particles.

They are deflected by electric and magnetic fields and have a negative charge.

Crooks setup a tube which contained a slit and a fluorescent screen. This created a cathode ray that travelled in a straight line. He then placed a magnet near the ray which moved, showing that the cathode rays were deflected by a magnetic field. Crooks noted that the charged particles in the B field experience a force and the cathode ray behaved as if they were negatively charged.

They are beams of tiny, negatively charged particles called electrons.

Arthur Schuster setup a discharge tube with an electric field. When this field was turned on, he noticed that the particles were deflected as a negative charge would be and attracted to the positive. This was further proof that cathode rays are negatively charged particles.

http://schools.cbe.ab.ca/b858/dept/sci/teacher/zubot/Phys30notes/investnurays/investnurays.htm

Impact of superconductors ie: maglev

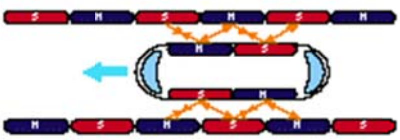
Because there is zero resistance in a super conductor, it is possible to observer the Meissner effect. The magnetic field produced by the super conductor due to current flow will be exactly equal to that of the field that produced it. This means that there are forces that push the superconducting magnet up and forces that pull simultaneously. This levitates the magnet.

This becomes more practical when used to levitate trains such as in maglev trains. Although the Meissner effect is not directly used to levitate trains, the use of the stronger magnetic field produced by super conductors allows the trains to levitate using significantly less energy than conventional magnets.

Superconducting magnets are also used to propel the vehicle, liner induction motor style. Propulsion coils located on the sidewalls are energised by a three phase current inducing an attractive and repulsive force propelling the maglev vehicle.

By understanding how to create such large magnetic fields in super conductors, we can begin to develop technology such as maglev trains which have significant advantages over their conventional counterparts including faster speeds due to no friction between the train and the track.

This strong magnetic fields that are required in maglev trains are only practically achievable using super conducting magnets. The use of conventional magnets would require significantly larger amounts of energy and would raise more challenges.



http://www.rtri.or.jp/rd/maglev/html/english/maglev_frame_E.html

http://www.o-keating.com/hsr/maglev.htm

Impact of the invention of the transistor

The invention of the transistor has had both positive and negative impacts on society.

Some of the positive impacts of the developments of transistors include the development of microchips and microprocessors. As a result, we have developed and miniaturised many electronic devices that before would have never of thought of or deemed completely impractical.

Solid state devices have greater reliability over thermionic devices such as valves due to their design which creates minimal heat loss. This means they can be employed in applications such as pacemakers, hearing aids, robots and other time and labour saving devices.

The increased prevalence of transistors in communications devices means a more globalised world where people from around the world can communicate with others in real time such as via satellite. The globalisation of the world has led to improved economic conditions in many countries and improved living standards. Mobile communications and broadband has also opened up rural and remote areas of the world providing an important lifeline in case of emergencies.

Access to information is also greatly increased through the use of the internet and the greater accessibility of computers and smartphones. Information can be stored on servers and accessed via the internet from around the world. The use of transistors in mobile phones means that they are capable of doing greater tasks (such as mobile email) than the first valve based computer.

However, there are also some negative impacts. Due to the cheaper nature of microchips in electronic devices, we have become a “throw-away society” where we communication devices have become more disposable leading to large amounts of e-waste. Even though the use of transistors in microprocessors means that we have far more powerful and accessible communications devices, it also means that we can always be contacted and we may find ourselves bringing our work at home and being always at work.

Possible applications of superconductivity, effects of those applications.

Currently, to enter a state of superconductivity, a superconducting material must be cooled to a below its critical temperature. This is often achieved using liquid helium or liquid nitrogen. This process can be impractical and expensive.

However, there are many possible applications of superconductivity. One future application for super conductors would be the creation of motors and generators. Because of the zero resistance in a super conductor, motors can be created that have greater energy efficiency and torque than conventional motors. As well, super conductor generators have as little has half the electrical losses of a conventional machine at full power. Due to the high density and efficiency of both motors and generators, the size and weight can be reduced.

With research into high temperature superconductors, it may be possible to transmit electricity and develop a power grid which contains next to zero resistance minimising energy waste and removing the need to transmit electricity at high voltages. However, currently high temperature superconductors are made of brittle ceramics which means they are very difficult to turn into wire or other useful shapes.

As well, due to the fact that there is not resistance in a superconductor, it is possible to store energy within a superconducting coil. Energy can be stored in a superconducting “battery” and retrieved instantaneously when there is a need to stabilise the power grid.

Superconductors also have computing applications, the Josephson junctions associated with super conductors allow for significant speed developments such as the development of quantum computers which would reach speeds far greater than those of today’s computers.

Superconductor’s greatest limitation at the moment is the need for cryogenic cooling of materials to enter a superconductive state. Even high temperature superconductors need to be cooling to 70K. If room temperature superconductors (such as 0C) could be found, superconductors would become more accessible and practical.

http://www.superconductors.org/Uses.htm

http://www.amsc.com/products/motorsgenerators/index.html