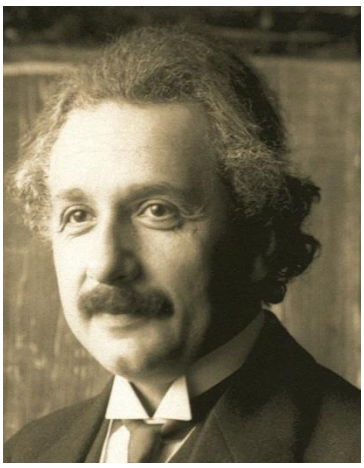
Today we are going to go back to July 16 1945, when for the first time human beings exploded an ATOMIC BOMB. The bomb in this case was exploded by the American Army, which had brought together a huge number of brilliant British and American scientists in 1942 to work in the town of LOS ALAMOS, in New Mexico, on the MANHATTAN PROJECT - the project of building an atom bomb before America's enemies in WORLD WAR II - Germany and Japan - could build one themselves. Three years later, the scientists thought that they had done it - and the explosion, in a deserted area of New Mexico, was designed to test whether they had managed to construct one. The test succeeded beyond their wildest dreams - the explosion created by the bomb was absolutely enormous. The explosion was filmed, and this is what it looked like:
https://youtu.be/hyiXpECM7eg?t=203

The blast was so intense that when ROBERT OPPENHEIMER (pronounced 'Op - en - hi - mer'), the lead scientist on the Manhattan Project, watched the explosion, he said to himself 'I HAVE BECOME DEATH, THE DESTROYER OF WORLDS' - quoting a classic Indian text (which was one of GANDHI's favourites) called THE BHAGAVAD GITA (pronounced 'Bag - vad Gee - tah').

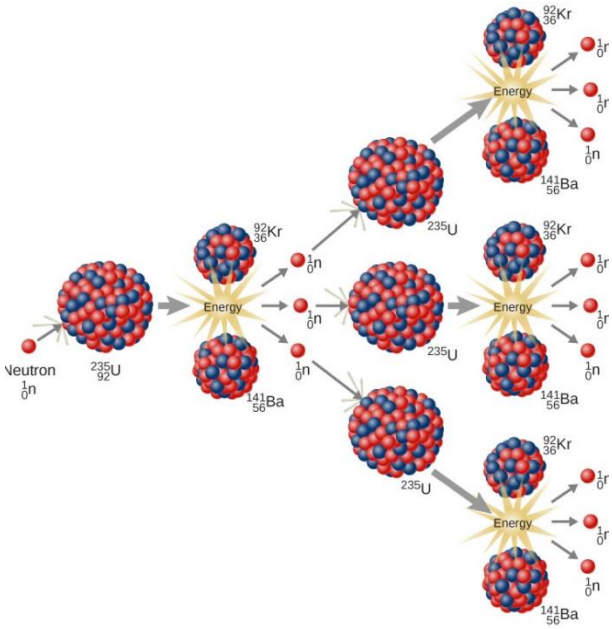
By the time the atom bomb was exploded, Germany had surrendered in World War II, after ADOLF HITLER died on 30 April 1945. But the Japanese were fighting on, and the Americans were faced with the prospect of having to invade the Japanese islands, which would mean thousands of American soldiers losing their lives in what was expected to be very fierce fighting. In order to avoid this, PRESIDENT HARRY TRUMAN - who had become President on 12 April 1945 when PRESIDENT FRANKLIN DELANO ROOSEVELT (pronounced 'Rooze - a - velt') died of ill health - ordered that one of America's new atom bombs be dropped on the Japanse city of HIROSHIMA (pronounced 'Here - oh - shee - ma') on August 6 1945, The devastation was unbelievable - about 80,000 people were killed by ONE bomb. But even that didn't persuade the Japanese to surrender. So Truman ordered that another atom bomb be dropped - this time on the city of NAGASAKI (pronounced 'Nag - a - sah - kee') on August 9 1945. This time the Japanese had to surrender - they had no answer to such a devastating weapon. This was the last time an atomic bomb was used in a war - atomic weapons have been regarded as simply too devastating to use, especially when the other side in the war also has atomic weapons, with the result that using atomic weapons would result in both sides suffering huge losses of life. But despite efforts to get countries with atomic weapons to give them up, there are still a significant number of countries that have stocks of atomic weapons ready to use, including the UNITED STATES, RUSSIA (which used spies to steal the knowledge of how to make atomic weapons from the Americans), CHINA, NORTH KOREA, the UNITED KINGDOM, FRANCE, INDIA, PAKISTAN, and ISRAEL.

And the funny thing is that these devastating weapons would not exist but for the efforts of a man who loved peace almost as much as GANDHI - the physicist ALBERT EINSTEIN (pronounced 'Ine - stine'). This is because it was Einstein who discovered that MASS and



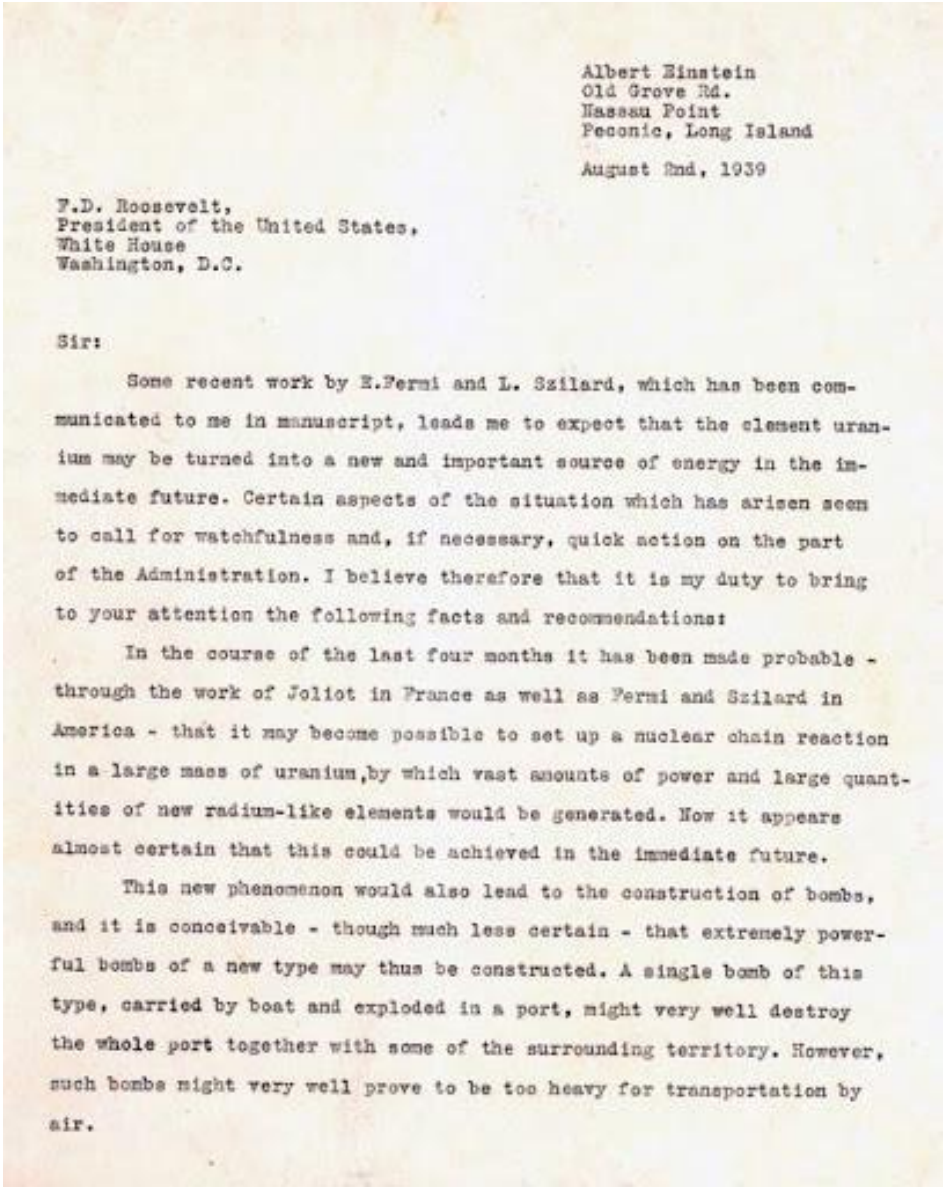
ENERGY are interchangeable - they amount to basically the same thing. This is very odd because you would normally think that mass and energy are opposites. Mass is what keeps you in the same place, while energy is what keeps you moving. It's because you have mass, that you need energy to get yourself out of bed in the morning, or to start walking or running. But Einstein argued that mass is just trapped energy, and provided people with an equation to tell how much energy (E) something with a mass M would have. This is the most famous equation of all time, and it goes like this: E = M x the speed of light (C) x the speed of light (C). In other words, $E = MC^2$, or 'E equals MC squared'. Now the speed of light is huge - light travels almost 3 million metres EVERY SECOND. So let's take a normal adult, who weighs about 50 kilograms, or 50,000 grams. The amount of energy that that person contains within them according to Einstein's equation is 50,000 x 3 million x 3 million. And that comes to 450,000 TRILLION units of energy (which are called JOULES). Which is huge. But that energy doesn't go anywhere because it's trapped.

However, this isn't the case with the sort of elements that MARIE CURIE (who I told you about on May 15) worked with; elements like URANIUM. Elements like this were made up of big, heavy atoms containing lots of NEUTRONS and PROTONS in their NUCLEUS. (I told you about these things on April 30, when we talked about the discovery of the ELECTRON.) Because these atoms were so big and heavy, they easily broke into smaller atoms - and every time they did this, there would be a LOSS OF MASS, so that the original atom was heavier than the two atoms it broke into. But this mass that was lost didn't just disappear - it turned into energy, in line with Einstein's equation. And this energy took the form of RADIATION, which moves out into the world whenever something like a uranium atom breaks up (or DECAYS) into two smaller atoms. It was this radiation that killed Marie Curie - too much of this energy entered her body and messed around with how it worked. Now what Einstein realised was that if you got a large amount of uranium, and fired neutrons at it, you could set off a CHAIN REACTION where a proton would break a uranium atom into two smaller atoms, which would then release some energy, but also some more protons which would then hit some more uranium atoms and make them break up, with more energy being released, and yet more protons which would break up yet more uranium atoms with more energy being released and more protons and so on and so on - with the number of uranium atoms being broken up increasing at every stage of the chain reaction, and the amount of energy being released at each stage also increasing. And what happens if you have a huge amount of energy being released



from a block of uranium which is being made to break up into smaller atoms? You get an explosion - and not just any explosion, but an absolutely huge, devastating explosion.

When Einstein realised that his equation meant that elements like uranium could be turned into weapons by making them break up into smaller atoms through a chain reaction, his big fear was that in GERMANY, scientists would also realise this and build atomic weapons that would be so devastating that HITLER could threaten to use them against anyone who didn't surrender to Germany, and in that way he could become ruler of the world. So Einstein wrote to PRESIDENT ROOSEVELT on August 2 1939, warning him that the United States had to start work on developing atomic weapons before any other country could get their hands on them. After America entered World War II on December 7 1941, Einstein's warning became really important - and the result was the Manhattan Project and the explosion of the first atomic bomb, which happened 75 years ago today, and changed the world forever. And all because of a brilliant Swiss scientist who liked fiddling around with clocks, and wondered what would happen to those clocks if they were made to rravel really, really fast. But we might say more about that some other time.



Albert Einstein
Old Grove Rd.
Nassau Point
Peconic, Long Island

August 2nd, 1939

F.D. Roosevelt,
President of the United States,
White House
Washington, D.C.

Sir:

Some recent work by E.Fermi and L. Szilard, which has been communicated to me in manuscript, leads me to expect that the element uranium may be turned into a new and important source of energy in the immediate future. Certain aspects of the situation which has arisen seem to call for watchfulness and, if necessary, quick action on the part of the Administration. I believe therefore that it is my duty to bring to your attention the following facts and recommendations:

In the course of the last four months it has been made probable - through the work of Joliot in France as well as Fermi and Szilard in America - that it may become possible to set up a nuclear chain reaction in a large mass of uranium,by which vast amounts of power and large quantities of new radium-like elements would be generated. Now it appears almost certain that this could be achieved in the immediate future.

This new phenomenon would also lead to the construction of bombs, and it is conceivable - though much less certain - that extremely powerful bombs of a new type may thus be constructed. A single bomb of this type, carried by boat and exploded in a port, might very well destroy the whole port together with some of the surrounding territory. However, such bombs might very well prove to be too heavy for transportation by air.