

### **Q1) What is Van de Graaff Accelerator?**

**Answer:** Type of high-voltage electrostatic generator that serves as a type of particle accelerator. This device has found widespread use not only in atomic research but has numerous applications in medicine and industry.

### **Q2) Who was Van de Graaff?**

**Answer:** Robert Jemison Van de Graaff is an American Physicist who was born on December 20, 1901 in Tuscaloosa, Alabama. His mother was Minnie Cherokee Hargrove and his father was Adrian Sebastian Van de Graaff. Robert attended the Tuscaloosa public schools and then attended the University of Alabama where he received a BS degree in 1922 and an MS degree in 1923. Both degrees were in mechanical engineering. He studied at the Sorbonne in Paris from 1924 to 1925 and while there, attended lectures by Marie Curie on radiation. In 1925 he went to Oxford University in England as a Rhodes Scholar. At Oxford he received a BS in physics in 1926 and a Ph.D. in physics in 1928. While at Oxford, he became aware of the hope of nuclear experimenters such as Ernest Rutherford, that particles could someday be accelerated to speeds sufficient to disintegrate nuclei. By disintegrating atomic nuclei much could be learned about the nature of individual atoms. It is from these ideas that Robert Van de Graaff saw the need for a particle accelerator

He invented the Van de Graaff generator back in October of 1929 at Princeton New Jersey.

### **Q3) How would the Van de Graaff accelerator operate?**

**Answer:** A high potential difference is built up and maintained on a smooth conducting surface by the continuous transfer of positive static charges from a moving belt to the surface. When used as a particle accelerator, an ion source is located inside the high-voltage terminal. Ions are accelerated from the source to the target by the electric voltage between the high-voltage supply and ground.

**Q4) What are the general utilizations of Van de Graaff accelerator?**

**Answer:** Atomic Physics, Nuclear Physics, Materials Science, Medicine. Specific applications and research areas are enormous and need a devoted paper to brief.

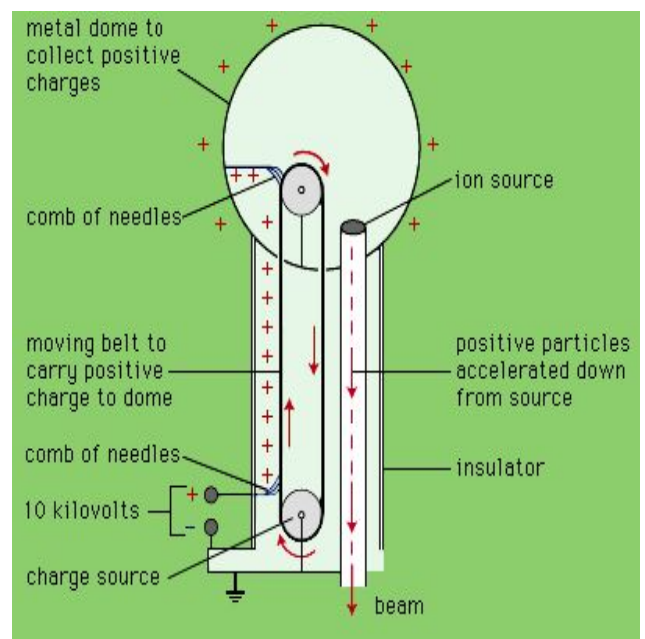
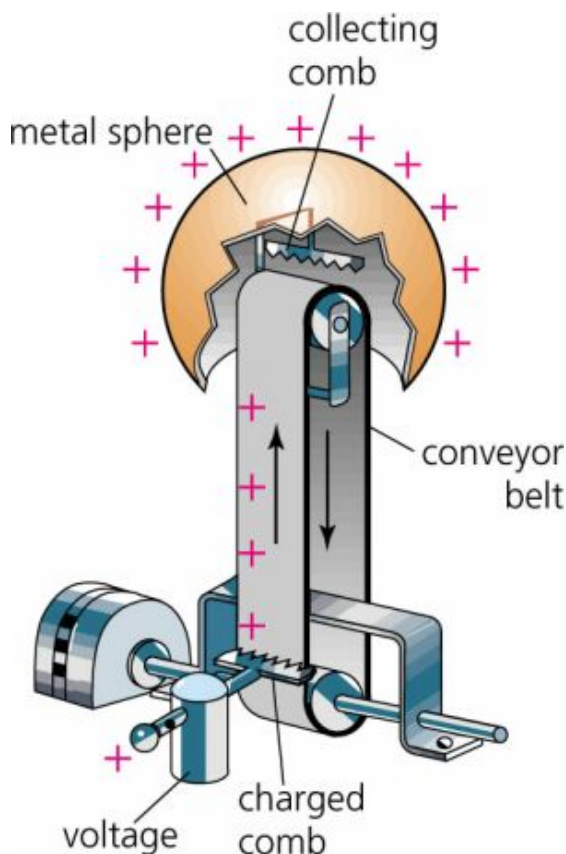
**Q5) Would it be an advantage to own a Van de Graaff accelerator in an Institute?**

**Answer:** Definitely, it is a privilege to have a Van de Graaff accelerator as it can serve in performing experiments that support advanced course work as well as in benefiting faculty and researchers in performing their research interests in various fields.

**Q6) Are there any differences between Van de Graaff Accelerators and Commercial Ion Implanters?**

**Answer:** Yes, indeed the implanters are limited to applications of direct ion implantations which are useful for surface modification. Van de Graaff accelerators on the other hand have countless benefits and are not so hard to maintain and serve many Departments in a University per se.

**Q7) Can you show us a simple Van de Graaff generator?**



**Q8) What is the maximum Energy obtained from an accelerator?**

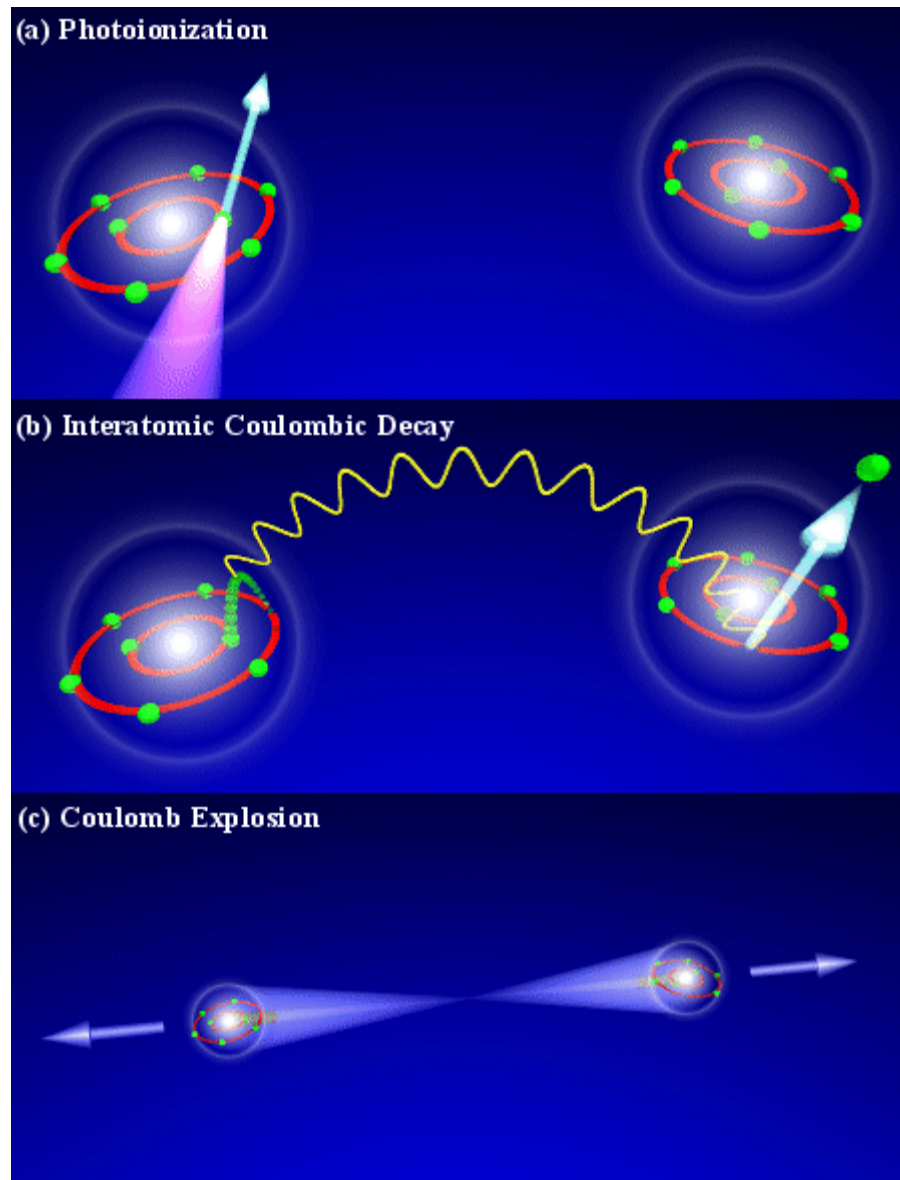
**Answer:** Several MV, like the 25-MV Holifield facility at Oak Ridge National Laboratory in Tennessee. This is a tandem Van de Graaff accelerator. Negative ions are first accelerated towards a positive high-voltage terminal in the center of a pressure tank. Inside the terminal the negative ions, which now have an energy in MeV equal to the terminal potential difference in megavolts ( $10^6$  V) times the charge of the ion, pass through either a foil or gas "stripper" and are stripped of electrons, producing a positive-ion beam. This beam is then accelerated a second time away from the high-voltage terminal. The limitation of these types of accelerators arises from the maximum practical potential difference that can be held by the charged surfaces. An additional problem in the tandem accelerator is the need to start with negative ions, which can be hard or impossible to obtain for some elements. Positive ion sources are available for a wider variety of elemental species. Positive ion sources can also produce ions of charge higher than one, which is all that is obtainable in negative ion sources.

**Q9) Name one Atomic Physics recently discovered novel application:**

**Answer:** Cold Target Recoil Ion Momentum Spectroscopy (COLTRIM). This is a technique that can be utilized to unfold lots of Atomic Physics mysteries and is currently being investigated for applications spanning: Ion-atom, photon-atom, photon-cluster, and photon-molecule interactions.

One interesting application was discovered few years ago, when Cederbaum et al. predicted a third, additional decay mechanism, to the Auger decay and the regular emission, termed Interatomic Coulombic Decay (ICD). This novel effect is calculated to become the dominant decay channel in many cases, once the excited atom is placed in an environment of other atoms. In that case the deexcitation energy is transferred to a **neighboring** atom, which releases it by emission of its most loosely bound electron. Here we report on an experimental observation of Interatomic Coulombic Decay in 2s ionized neon-dimers. The decay is unambiguously identified by detecting the energy of two Ne<sup>1+</sup> fragments and the

ICD electron in coincidence, yielding a clean experimental spectral distribution of the ICD electrons.



**Q10) How can we benefit from Van de Graaff accelerator in Materials Science?**

**Answer:** The most obvious application is in studying the Rutherford Backscattering spectroscopy of processed samples, Ion-Beam mixing and surface modifications, direct implantation of gaseous species into semiconductors, dielectrics and metals, Engineering band-gaps, and many more applications.

**Q11) Can we obtain devoted beam-lines for various applications?**

**Answer:** This is typically the case in academic and research Institutes hosting such facilities. IN our Institute, we have four devoted beam-lines.

9) Name some of the applications in Atomic Physics?

**Q12) Is Ion Beam assisted surface modification different from direct implantation?**

**Answer:** Of course; Ion-Beam Mixing and Surface Modification utilizes the knock-on principle of Heavy accelerated ions like Ar, Kr in redistributing the as-deposited materials. Thus, aiding in forming a meta-stable structure of with engineered fundamental properties.

**Q13) Demonstrate how certain experiments performed in the accelerator can benefit academically class room?**

**Answer:** One elective advanced course can be devoted to exploring the advantages of Rutherford Backscattering (RBS) in characterizing the structural and depth analysis of a processed sample. Upon utilizing channeling techniques, one can also add the benefit of exploring microcrystalline structures embedded into the processed matrix by carefully analyzing the yield of the backscattered ions.

**Q14) Name one other difference between Ion-Beam Mixing and Ion-Implantation of say Rare-Earth metals into Silicon?**

**Answer:** Ion implanter can implant Er deep into the materials with minimal Er distribution close to the surface, while Ion-Beam Mixing would permit the distribution to start right from the surface as it is redistributing all the constituents lying in the path of the energetic bombarding ions. Hence for a device that relies on the distribution of electrically and optically active impurity centers like Er, one may conclude that Ion-Beam Mixing techniques like Van de Graaff accelerators are of great importance indeed.

**Q15) Are Ion-Beam Mixing techniques limited to certain concentrations?**

**Answer:** No, we can surely mix materials beyond known solubility limits