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How to get the Nobel Prize in Physics*

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Abstract

Every year, on the 10th of December, one piece is added to the history of science. This is the day when the Nobel Prizes are awarded to those scientists who "during the preceding year have conferred the greatest benefit on mankind". The Nobel Prize carries the highest prestige and fame of all distinctions in the world of science. There have been many speculations regarding the prize: What effect does it have on its recipients? Does it boost their research activities or does it kill them? Is it merely an after-the-fact recognition of important steps in the history of science, or does it also create history by changing the directions along which science develops? What role does it play in the sociology of science? Is it a prize for leaders of big research teams or is there a preference for the genius working completely on his own? Are there equal opportunities for men and women, for Swedes and Russians, for black and white? Where does one find the track that leads to Stockholm?

There are many questions one might ask about the Nobel Prizes, and I would not be able to answer them all. Today I shall address some questions for which I do have fairly well-supported answers. At the end I shall forward to you five golden rules of how to get the Nobel Prize. These five commandments have been given by one who knows from personal experience of how one gets the Prize.

Alfred Nobel

Alfred Nobel was born in Stockholm, Sweden, in 1833. He was described by one of his biographers as "a prematurely developed, unusually intelligent, but sickly, dreamy and introspective youth". School education in St Petersburg, Russia, where his father, Immanuel Nobel, had started a factory for making explosives. Learned several languages. Later Alfred's father, together with his sons Alfred and Emil, set up a laboratory in Stockholm. One day, in 1864, the building was destroyed by an explosion which killed five persons, including Alfred's brother. This disaster became a strong incentive for Alfred to work on his greatest invention, dynamite.

Formula for making dynamite: Combining 3 parts of nitroglycerine + 1 part diatomaceous earth (soil consisting of the skeletons of one-celled organisms called diatomes) makes a powder that can be thumped, bumped and even burned without exploding. However, a percussion cap will set the powder off in a powerful blast.

This powerful substance opened up vast areas of wilderness for human settlement and played an important role in the industrial development of the world, but Nobel's involvement in the weapons industry also earned him some public scorn and the nick-name "Merchant of Death".

Nobel had many patents. Dynamite was patented in 1866; the total number became as high as 355, including smokeless gunpowder, synthetic rubber, synthetic leather, telecommunication devices, safety alarms. He was a pioneer in founding multinational companies: 90 factories in 20 countries. R&D-laboratories in Germany, France, Scotland, Italy, Sweden. Most of these operations were very successful and brought him a huge fortune.

What he did *not* have: a place he could call his home, although he owned big mansions in Paris, on the Italian Riviera and in Sweden. Always on the move from one place to another: "The wealthiest vagabond in Europe". He was not a very happy man. In an autobiographic note he describes himself as leading "... a miserable half-life, which ought to have been choked to death by a philanthropic physician, as soon as, with a howl he entered life".

Two personalities merged in one:
(1) Scientist and inventor
(2) International industrialist and businessman.

Fig. 1. Alfred Nobel on a photograph from 1896, the last year of his life.

* Chairman of the Nobel Committee for Physics addressing the young scientists at the Pre-symposium.

Nobel would have liked to devote all his time and genius to the first personality. He talked about his industrial activity as intruding on his interest in science and research. There was also a third personality, one of literary authorship, but this personality was not developed nearly as far as the other two.

Alfred Nobel never married, but he maintained a lifelong friendship with Bertha von Suttner, an Austrian author who organized peace conferences and was a strong spokesman for disarmament – and who was later to receive the Nobel prize for peace. However, Alfred did not think her approach to these questions was very effective. He believed that his own inventions of explosive weapons and other instruments of war would be the ultimate deterrant which would make warefare impossible in the future, and he told her so in one of his letters.

There was also an unhappy liaison with another Austrian lady, Sofie Hess, who was only twenty years old when they first met in 1876. She was a very attractive young woman, but unfortunately she did not have the manners or education required in those Victorian days, she was just a pretty face. An impossible My Fair Lady-type of relation developed which lasted for eighteen tormenting years.

One year before his death Nobel made his will. He did this without any professional advice or assistance since he disliked and distrusted lawyers. In this one-page handwritten document he prescribed that his fortune should be used to reward eminent scientific discoveries and inventions, literary productions of the highest standing and "idealistic tendency" and important contributions to the establishment of peace in our world.

Nobel died from a brain haemorrhage in his mansion in San Remo, Italy, on the 10th of December 1896. He died under circumstances which he had much feared: without any friend or relative being present at his deathbed, unable to communicate with a doctor. He died as an alien in a foreign country.

The Will

"After due consideration I express the following as my last will".

His assets shall constitute a fund and the interest obtained shall be used to award prizes to those "who during the preceding year have conferred the greatest benefit on mankind". This, of course, is an impossible task. Usually it takes more than a year for a scientific discovery or invention to show its significance for the development of its field. And, besides, what is "the greatest benefit on mankind"? The legal interpretation of the will, which was formulated a few years later, took a more realistic stand.

Five prize categories are named and four prize awarding institutions: Physics (Royal Academy of Sciences), Chemistry (also RAS), Physiology or Medicine (Karolinska Institute), Literature (Swedish Academy) and Peace (a committee of five persons appointed by the Norwegian Parliament – at the time Norway and Sweden were joined in a union which was to be peacefully dissolved in 1905). The international character of the prize is laid down. No priority shall be given to Scandinavian scientists.

"This is my only valid will and replaces all my previous testamentory stipulations if any such should be in existence after my death".

"Finally I declare as my last will and expressed wish that after my death my arteries should be cut open and when this has been done and other indications of permanent death have been established and affirmed by a competent physician, the corpse should be incinerated in a so-called cremation furnace". (The terrifying possibility of being buried alive was an obsession of many people at the time, including Alfred Nobel. So he took several measures to prevent such a thing to happen.)

At the time of his death Nobel's assets amounted to 33.2 million Swedish kronor, about 4 million US dollars – an enormous fortune in those days. Today the total assets of the Nobel Foundation are about two billion Swedish kronor. The will was contested for almost four years. As Executor of the will Nobel had appointed his young assistant, Ragnar Sohlman (grandfather of the present Director of the Nobel Foundation, Michael Sohlman), who was a chemist without any experience of handling intricate legal matters. But he had won Nobel's confidence and he did a heroic job in managing to secure the right of disposition of Nobel's assets in different countries, capitalize these assets and convince Nobel's nephews (and their wives) that they should accept the rather modest endowment that uncle Alfred had bestowed upon them in his will and leave the rest for the fulfilment of Alfred's visionary plans.

Incidentally, Sohlman also had to convince the Royal Swedish Academy of Sciences that it should assume the responsibility as a prize awarding institution. Some influential members of the academy did not consider it a good

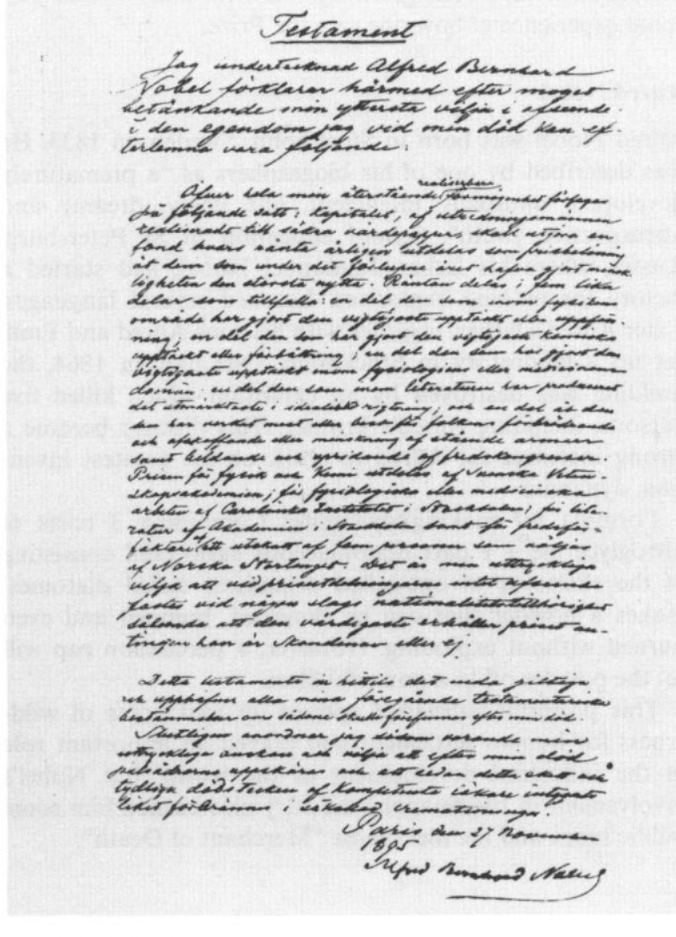

Testament

Fig. 2. Nobel's will.

idea to give away big amounts of money to people in other countries. King Oscar II was also rather sceptical of it for various reasons. (At this point it should be emphasized that the academy is an independent body. It makes its decisions, both as a prize awarding institution and in other matters, without consulting the political government or the royal family.)

It was finally decided to organize the Nobel Foundation as legatee and administrator of the Nobel fund capital, while the various bodies named in the will agreed to undertake the responsibility of awarding the prizes.

Procedure for selecting Nobel laureates in physics

The selection committee is not trying to find the world's best physicist since it would be presumptuous to believe that one can identify such a person. There is not just one contribution to physics or one physicist worthy of a Nobel Prize, but several. What we try to do, therefore, is to select one individual (or up to three) who is particularly worthy of recognition that particular year. Awards are strictly based on scientific merit by peer judgement. No open competition is accepted and no lobbying. A prize may be divided between a maximum of three individuals (according to statutes established in 1900). It may be equally divided between two works, each of which is considered to merit a prize.

The work of the Nobel Committee (five members + secretary) goes on during the whole year with peaks in the temperature at certain times:

September of the preceding year

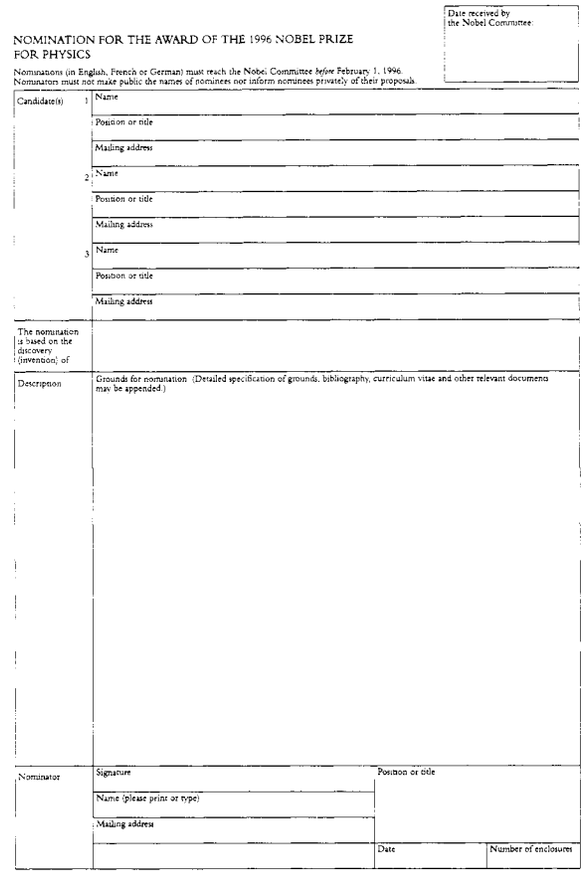
More than two thousand invitations to nominate candidates go to physics professors at universities and to physicists at other research institutions around the world. The list is changed every year, which reflects our desire to have the widest possible involvement of the global community of physicists. Some individuals have permanent right to submit nominations: members of the Royal Academy of Sciences and its Nobel Committees, previous Nobel laureates, physics professors at Scandinavian universities. The nomination form is quite simple, one page only, with the possibility of appending relevant documentation. Remember that a nomination is valid for one year only. If your candidate does not receive the prize that year you must be persistent and resubmit your nomination the following year.

January 31

This is the last day for submitting nominations. Committee meets to browse through all 300 or so nominations. Now, let us assume that your name is among those 250 or so individuals who have got a valid nomination. Some person somewhere in the world thinks that your recent paper on trapped quarks and other charged particles is so great that you deserve the Nobel Prize in physics. Your name will therefore appear on one page (or several if you got more than one nomination) of the book of nominations which is now put together.

February

Experts are chosen to assist the Committee in the evaluation process. Internationally recognized scientists are asked



NOMINATION FOR THE AWARD OF THE 1996 NOBEL PRIZE FOR PHYSICS

Nominations (in English, French or German) must reach the Nobel Committee *before* February 1, 1996.
Nominators must not make public the names of nominees nor inform nominees privately of their proposals.

Date received by the Nobel Committee:

Candidate(s)

1 Name
Position or title
Mailing address

2 Name
Position or title
Mailing address

3 Name
Position or title
Mailing address

The nomination is based on the discovery (invention) of

Description

Grounds for nomination (Detailed specification of grounds, bibliography, curriculum vitae and other relevant documents may be appended.)

Nominator

Signature
Position or title
Name (please print or type)
Mailing address
Date
Number of enclosures

Fig. 3. Nomination form for the Nobel Prize in physics 1995.

to give their opinion on one or several candidates, on questions of priority, on the status of a certain research field, etc. The reviewers are reminded that their reports will be kept strictly confidential for fifty years, which often makes it easier for them to be frank in their reports. Each reviewer receives the material that was attached to the nominations concerned.

Members of the Committee have for several years been reading your papers and listened to your talks at conferences, and this particular year the Committee wants to take a closer look at your achievements. Professor Trap in Berkeley, the internationally leading authority in the field, is asked to make an external expert report for the Committee and agrees to do so. Similar requests regarding other candidates go to a dozen or so experts in other fields. Committee members also set themselves to work, contemplating all the nominations, reading papers published by the nominees and other relevant authors, reading review articles, etc.

May

Reviewers' reports are submitted. These reports present extremely interesting reading and one can only regret that they have to be kept secret for as much as fifty years. In all confidence I can tell you that professor Trap is quite enthusiastic in his report. In his opinion you have made a discovery that shatters common wisdom and has changed the direction in which physics will now develop. There is general agreement in the Committee with Professor Trap's appraisal.

June and July

Busy summer "vacation" for Committee members. Drafts for the various sections of the Committee report to the Academy are written by the Committee members. The whole field of physics is surveyed. Members of the Committee go to various conferences to keep themselves informed about recent developments and read papers of "hot" candidates, you being one of them. Several meetings are held with the Committee. More good news for you: It appears that your candidacy competes strongly with all the others.

August

Nobel Committee makes its final decision. After a full day of deliberations the Committee has reached its final decision and is prepared to submit its report and recommendations to the Academy. You may not believe me when I tell you that the person finally selected by the Committee is – you! Congratulations!

But, of course, you don't know yet what's in store for you. Secrecy still prevails. The Committee, however, feels very relaxed after a tough job and goes out for dinner at the best restaurant they can find. Alfred Nobel pays. I should tell you that this is not necessarily so. You see, the Committee may or may not be unanimous in its decision. As an incentive for making a unanimous decision we have agreed that only then can we invite ourselves to that superb dinner. If the decision is not unanimous we can only go to a hamburger place – and do so at our own expence!

September

Physics "Class" makes its decision. Before the physics section of the Academy – we call it the physics "Class" – makes its decision the Chairman of the Committee gives a report on the Committee's standing in all the various subfields of physics and some member of the Committee gives a detailed presentation of the work recommended for the award. Discussion follows, questions are asked, Committee has to be well prepared. Usually the recommendations from the Committee are accepted by the Class but they may be modified or even overruled.

This hypothetical year the discussion is very lively. Everyone is in favour of the proposal put forward by the Nobel Committee, and the recommendation sent to the Academy is the same as that of the Committee: The recipient of this year's Nobel Prize in physics should be – you! Congratulations!

Mid-October

Academy makes its final decision. The session starts at 10 o'clock. Chairman of the Nobel Committee gives a report on the work of the Committee and reads out its recommendation. A presentation of your work is given by a member of the Committee and your photograph is shown on the over-head projector. The Secretary General of the Academy reads out the recommendation given by the physics Class – this year the same as that of the Committee. Discussion follows in which one member of the Academy – a biologist – expresses some concern that free quarks can now be observed. Is this the end of asymptotic freedom? Of course it is!

Academy now proceeds to a vote. There are three options: (1) candidate or candidates recommended by the Nobel Committee; (2) other candidate(s) for whom a valid nomination has been obtained; (3) no prize awarded. When all votes have been counted the President of the Academy reads out the result: The Academy has unanimously decided that this year's Nobel Prize in physics shall be awarded to – you! Congratulations! You made it!

Now the temperature reaches a peak. It's all very hectic. Reporters from TV, radio, newspaper, both national and international, are waiting for the doors of the session room to open and the names of the laureates and the citations to be officially announced by the Secretary General of the Academy. Before doing this, however, he makes a telephone call. This call goes to you. The time is about noon in Sweden and you may be living in California, time difference nine hours. So it's three in the morning when you hear those provocative signals from the telephone ...

Conferment ceremony, Nobel Banquet and the rest of your life

You should arrive in Stockholm a few days before the conferment ceremony, not only to get rid of the jet-lag but also to be able to go to a reception and a family dinner at the Academy, to have lunch with your Ambassador and to take part in other social activities. You have received an invitation for dinner at the Royal Palace on the evening of the day after the conferment. A limousine with chauffeur and an attending attaché from the Swedish Foreign Office are at your disposal; you live at Grand Hotel, the finest hotel in Stockholm.

Before you actually get the Prize in your hands you should also carry out one obligation. This is to deliver your Nobel lecture, a sheer pleasure of course since you only have to talk about what's on your mind anyway, i.e. your own research. Your lecture takes place in the Beijer Hall of the Academy and is published in the annual "Les Prix Nobel" series of (white cover) books.

Fig. 4. Home of the Royal Swedish Academy of Sciences, prize awarding institution for the Nobel Prizes in Physics and Chemistry and (since 1969) the Bank of Sweden Prize in Economic Sciences in memory of Alfred Nobel. The Academy was founded in 1739 as an independent, non-governmental organization which promotes mathematics and natural sciences (mainly).

Conferment ceremony takes place in Concert Hall of Stockholm on 10th of December at 4:30 p.m. Flower decorations are a gift from the town of San Remo where Nobel lived in his last days. There are no empty seats. Many prominent persons are found in the audience with many medals and other decorations, ladies beautifully dressed. King Carl Gustaf and Queen Silvia and Prince Bertil and Princess Lilian are throned on the podium. Members of the prize awarding institutions are also seated there, all dressed in black tails and white shirts. At a distance they look like a mountain of penguins. And in front of this impressive crowd sit the laureates. One of these Nobel laureates is you!

The physics prize is the first one to be conferred. After a five minute presentation of your work, made by the Chairman or some other member of the Nobel Committee, you step forward to receive your Nobel Prize "from the hands of His Majesty The King". Fanfare! Applause! Now, stay cool! Don't forget to bow reverently to His Majesty, then turn left and do the same to the members of the Academy and finally turn right and make a bow to the audience. When you have done all this you may return to your seat and relax.

The Nobel Banquet in the City Hall of Stockholm starts right after the conferment ceremony. It is the most magnificent banquet of the year. Spirits are high. You have been asked to express your feelings in a two minute speech and have joyfully agreed to do so. Loud applause! After the dinner everyone goes to the Golden Hall to dance. Queen Silvia, who has been sitting on your right side at the dinner table, suggests that you go to the room where all the new Nobel Diplomas and golden medals are on display, a proposal you can hardly turn down.

Next morning – late next morning – you wake up to a new life. From now on you know the answers to all questions, not only those within your field of research or even within the entire field of physics. From now on you are considered an expert on economy, politics, extra-terrestrial phenomena, extra-sensory perception, love affairs – everything! From now on you will have to be very selective in accepting invitations to all corners of the world and to all kinds of meetings. But, after all, you are still young and dedicated to your scientific work, so I am sure you will manage to maintain your personal integrity and scientific productivity even as a Nobelist.

Dr Esaki's golden rules

This would be a good place for me to end my presentation. But I realize that I haven't fulfilled my promise to you. I have described the road that leads to the Hall of Fame, but I have not yet told you how to get on that road. And this I have promised to do. So let me end my presentation by showing you Dr Esaki's Five Golden Rules of how to get the Nobel Prize. Dr Esaki knows what he is talking about as he himself received the Nobel Prize in physics in 1973 for his experimental discoveries regarding tunneling phenomena in semiconductors. His Golden Rules were first presented two months ago at a meeting in Lindau with all Nobelists in physics and several hundred postgraduate students. Here are the rules:

Rule number one: Don't allow yourself to be trapped by your past experiences. If you allow yourself to get caught up in social conventions or circumstances, you will not notice the opportunity for a dramatic leap forward when it presents itself. Looking back at the history of the Nobel Prize, you will notice that most of the laureates have received the Nobel Prize for work they had done during their thirties. In my case I was 32 years old when I developed the "Esaki tunnel diode". The point that I am trying to make is that younger people are able to look at things with a clearer vision, one that is not clouded by social conventions and past history.

Rule number two: Don't allow yourself to become overly attached to any authority in your field – the Great Professor, perhaps. By becoming closely involved with the Great Professor, you risk losing sight of yourself and forfeiting the free spirit of youth. Although the Great Professor may be awarded the Nobel Prize, it is unlikely that his subordinates will ever receive it.

Rule number three: Don't hold on to what you don't need. The information-oriented society facilitates easy access to an enormous amount of information. The brain can be compared to a personal computer with an energy consumption of about 25 watt. In terms of memory capacity or computing speed, the human brain has not really changed much since ancient times. Therefore, we must constantly be inputting and deleting information, and we should save only the truly vital and relevant information. As the president of a university, I have the opportunity to meet with many people and to exchange meishi (name card) with them. I try to discard the name cards as soon as possible, so that I always leave maximum memory space open. (I'm kidding. of course.)

Rule number four: Don't avoid confrontation. I myself became embroiled in some trouble with the company I was working for many years ago. At times it is necessary to put yourself first and to defend your own position. My point is that fighting is sometimes unavoidable for the sake of self-defence.

Rule number five: Don't forget your spirit of childhood curiosity. It is the vital component for imagination.

Having listed these five rules, let me say that they do not constitute the sufficient conditions for success. They are merely suggested guidelines. Good luck!