S. HRG. 111–985

NOMINATION OF CARL E. WIEMAN, PH.D., TO BE ASSOCIATE DIRECTOR FOR SCIENCE, OFFICE OF SCIENCE AND TECHNOLOGY POLICY, EXECUTIVE OFFICE OF THE PRESIDENT

HEARING

BEFORE THE

COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION UNITED STATES SENATE

ONE HUNDRED ELEVENTH CONGRESS

SECOND SESSION

MAY 20, 2010

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SENATE COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION

ONE HUNDRED ELEVENTH CONGRESS

SECOND SESSION

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NOMINATION OF CARL E. WIEMAN, PH.D., TO BE ASSOCIATE DIRECTOR FOR SCIENCE, OFFICE OF SCIENCE AND TECHNOLOGY POLICY, EXECUTIVE OFFICE OF THE PRESIDENT

THURSDAY, MAY 20, 2010

U.S. SENATE,
COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION,
Washington, DC.

The Committee met, pursuant to notice, at 2:53 p.m. in room SR–253, Russell Senate Office Building, Hon. Mark Pryor, presiding.

OPENING STATEMENT OF HON. MARK PRYOR, U.S. SENATOR FROM ARKANSAS

Senator PRYOR. I'll go ahead and call this hearing to order. I welcome everyone to this meeting of the Committee on Commerce, Science and Transportation, and specifically to the nomination hearing of Dr. Carl Wieman, to be Associate Director for Science of the Office of Science and Technology Policy.

I'd like to welcome our nominee. Today we'll consider his nomination. There are some Senators who I know will not be in attendance today. So what we'll do is we'll leave the record open for a few days for those Senators who would like to submit questions.

The OSTP can have up to four Presidentially-appointed, Senate-confirmed associate directors. If confirmed, Dr. Wieman will be responsible for coordinating, monitoring, and advising on national research priorities and inter-agency programs within OSTP's portfolio. According to OSTP Director Dr. Holdren, the Associate Director for Science will oversee STEM education activities and he will act as an expert adviser to the OSTP Director.

The OSTP is a critical arm of the White House. The advisers offer timely technical counsel to the President and his senior staff on significant policy matters. Staff members inform good policy through sound science and coordinate among science and technology-related agencies.

Finally, the OSTP strives to make sure Americans' financial investments make the best possible contribution to our collective prosperity, public health, national security, and environmental quality.

Dr. Carl Wieman has extensive teaching experience, has received numerous awards, and has conducted extensive research in atomic and laser physics. Currently, he serves as Professor of Physics and

Director of Collaborative Science Education Initiatives at both the University of British Columbia and the University of Colorado. From 1984 through 2006, he was a Distinguished Professor of Physics and Presidential Teaching Scholar at the University of Colorado. Notably, he shared the Nobel Prize in Physics and 2001 for the creation of the Bose-Einstein condensation, a new form of matter that I'm sure we'll ask about in a few minutes so we can try to understand what that means.

Dr. Wieman was the founding Chair of the National Academy of Sciences Board on Science Education. Distinguished institutions have conferred on him numerous prestigious awards, including the National Science Foundation's Distinguished Teacher-Scholar Award in 2001, the Carnegie Foundation's U.S. University Professor of the Year Award in 2004, and the American Association of Physics Teachers Hoersted Medal in 2007.

We look forward to hearing Dr. Wieman's statement and examining his credentials for this important post. But first, we have a friend and guest of the Committee here to introduce Dr. Wieman, and it is Senator Mark Udall from Colorado. Senator Udall.

STATEMENT OF HON. MARK UDALL,
U.S. SENATOR FROM COLORADO

Senator MARK UDALL. Mr. Chairman, thank you for giving me an opportunity to add additional comments to the wonderful introduction you just made of Dr. Wieman. I've known Carl for a number of years through his work as a Professor of Physics and a Presidential Teaching Scholar at the University of Colorado. He was born in Oregon, Mr. Chairman, but we're proud to claim him as a Coloradan. He is, as you pointed out, the President's nominee to be the Associate Director for Science at the White House Office of Science and Technology Policy.

I'm deeply pleased that President Obama recognizes the talent and creativity that Carl will bring to our discussions on science and in particular STEM education. You mentioned that Dr. Wieman won the 2001 Nobel Prize in Physics for producing a new state of matter called the Bose-Einstein condensate. I once asked him, can you see it, and you should maybe perhaps ask him that during his testimony.

I also know in front of the Committee recently you had two Apollo astronauts, including the first human to walk on the Moon, Neil Armstrong, who's an iconic figure to all of us. While no doubt this is a remarkable achievement, I would note that 12 men have walked on the Moon. How many people, however, can say they've created a new state of matter?

Interestingly enough, Carl's Nobel Prize-winning work built upon earlier work in laser cooling by the other Nobel Prize winner in President Obama's Administration, Secretary of Energy, Steven Chu.

While Dr. Wieman is most famous for winning the Nobel Prize, it is his commitment to teaching science to others that is Carl's most remarkable quality in my eyes. He's an expert not just in teaching science, but in improving how it is actually taught. He has devoted his entire professional life to STEM education. He's currently the Director of the Carl Wieman Science Education Initiative

and, as you mentioned, still spends part of his time at the University of Colorado leading the science education initiative that he founded.

He was a founding Chair of the National Academy of Sciences Board on Science Education and he has won many accolades for his teaching.

Mr. Chairman, if we as the United States are going to continue to be a global leader, if we're going to remain economically competitive with other nations, we need to teach our children math and science and we need to cultivate the next generation of scientists and engineers. Currently, it's no secret that we're falling behind in that regard.

Carl knows better than anyone how to improve STEM education. That skill and his experience will be an invaluable addition to the Obama Administration. I hope and trust and urge you to approve his nomination and I encourage you to move consideration to the Senate floor in an expeditious manner.

Thank you again, Mr. Chairman, for the opportunity to appear before your committee, and I would note one final fact, that it takes two Udalls to handle one Pryor. Thank you for giving me the chance to introduce Dr. Wieman today.

Senator PRYOR. Thank you.

Senator Udall.

STATEMENT OF HON. TOM UDALL,
U.S. SENATOR FROM NEW MEXICO

Senator TOM UDALL. I want to make sure we don't let this witness leave without asking him some tough questions.

Senator MARK UDALL. I agree with that.

[Laughter.]

Senator PRYOR. We've got him under oath now. We'll take care of him.

Good. Thank you, Senator Udall. We appreciate it.

Senator Udall, did you have an opening statement?

Senator TOM UDALL. No, just go on. I'm here to hear his testimony and ask some questions.

Senator PRYOR. Sure, great.

Dr. Wieman, the floor is yours.

STATEMENT OF CARL E. WIEMAN, PH.D.
ASSOCIATE DIRECTOR-DESIGNATE FOR SCIENCE,
OFFICE OF SCIENCE AND TECHNOLOGY POLICY,
EXECUTIVE OFFICE OF THE PRESIDENT

Dr. WIEMAN. Thank you, Mark, for that generous introduction.

Chairman Pryor, Senator Udall, and distinguished members of this committee: It's a great honor to appear before you today. I'm grateful for President Obama's confidence in nominating me to be Associate Director for Science in the White House Office of Science and Technology Policy. OSTP's science portfolio is remarkably broad and I appreciate the work of this committee in addressing many of those issues and, if confirmed, I look forward to working with all of you.

I grew up deep in the forests of Oregon and I can still remember first getting on the school bus and riding many miles over unpaved

roads to attend first grade. I never imagined that was the first step on a journey that would lead me to sitting before you today to discuss my nomination.

My early education was in a tiny school in rural Oregon and was greatly supplemented by reading many books from the public library in the distant town of Corvallis. For middle and high school, my family relocated to Corvallis, the home of Oregon State University, to allow me and my siblings to attend a better school system. After completing high school, getting on an airplane for the first time to go off to college to MIT was another big step on my journey to sitting here today before you.

I nearly failed my first physics class at MIT, but I was fortunate enough to have the opportunity to work in a physics research lab. There I discovered that doing science was far more rewarding than studying about science. My work in the lab became a consuming passion and gave me a superb education. I became fascinated with what one could learn from blasting atoms with light from a new type of laser, and I saw this as an exciting unexplored territory.

Exploring that territory led me to graduate work at Stanford University and ultimately to a long and successful career of physics at the University of Colorado. I feel that my strengths as a scientist are recognizing opportunities a little earlier and working a bit harder than others, and being able to build things that have unique capabilities, usually while held together with duct tape and costing a fraction of the price of the competition. All these talents may prove useful in government service should I be confirmed.

I've also devoted much of my career to the issue of science education. As a young assistant professor, I approached teaching, as most firsts do, figuring out the subject to be taught very clearly in my own mind and then explaining it to the students, expecting they would understand it the way I did. However, when I actually measured what my students were learning carefully, I discovered that what I thought was clear and simple the students found incomprehensible, and I was quite puzzled and frustrated by this result.

That experience actually led me to what's now been nearly a 20-year effort of mine to understand how people learn science and how to teach it more effectively. I have conducted extensive research in this area and I have worked with a number of groups, particularly the National Academy of Sciences, who share my interest in improving science, technology, engineering, and mathematics—that's STEM—education.

This effort has led me to understand both my early failings as a teacher, but also how I and others can teach science much more effectively. This is very important because our global economy is increasingly based around science and technology. To maintain U.S. economic competitiveness and leadership in innovation, we need to also have leadership in STEM education. This will both enhance the scientific and engineering workforce and the technical literacy of all our citizens, providing them with complex problem-solving skills that they can use in many aspects of their jobs and lives.

President Obama has assembled an exceptional scientific team, including Energy Secretary Chu, who has been a friend of mine for decades and first talked to me about the importance of government

service, and OSTP Director John Holdren, and I look forward to the opportunity to work with them as well as members of this committee and this Congress to develop effective and efficient programs that will maintain our leadership in scientific research, to measure the results of our investments in this area, and to greatly improve STEM education.

If confirmed, I hope to use my scientific background as well as my experience in STEM education to deepen science policy dialogue and to enhance progress in STEM education in this country.

I'm pleased to try and answer any questions you may have. Thank you.

[The prepared statement and biographical information of Dr. Wieman follows:]

PREPARED STATEMENT OF CARL E. WIEMAN, PH.D., ASSOCIATE DIRECTOR-DESIGNATE FOR SCIENCE, OFFICE OF SCIENCE AND TECHNOLOGY POLICY, EXECUTIVE OFFICE OF THE PRESIDENT

Chairman Rockefeller, Ranking Member Hutchison, and distinguished members of this Committee, it is a great honor to appear before you today. I am grateful for President Obama's confidence in nominating me to be the Associate Director for Science in the White House Office of Science and Technology Policy (OSTP).

OSTP's science portfolio is remarkably broad, and I appreciate the work of this Committee in addressing many of those issues. If confirmed, I look forward to working with all of you.

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Our global economy is increasingly based on science and technology. To maintain U.S. economic competitiveness and leadership in innovation, we need to also have leadership in STEM education. This will both enhance the scientific and engineering

workforce and the technical literacy of all our citizens, providing them with complex problem-solving skills they can use in many aspects of their jobs and lives.

President Obama has assembled an exceptional scientific team, including Energy Secretary Chu, who has been a friend for decades and first talked to me about the importance of government service, and OSTP Director, Dr. Holdren. I look forward to the opportunity to work with them, as well as the members of this committee and this Congress, to develop effective and efficient programs that will maintain our leadership in scientific research, to measure results of our investments in this area, and to greatly improve STEM education. If confirmed, I hope to use my scientific background, as well as my experience in STEM education, to deepen the science policy dialogue and to enhance progress in STEM education in this country.

I am pleased to try to answer any questions you may have.

Thank you.

A. BIOGRAPHICAL INFORMATION

1. Name (Include any former names or nicknames used): Carl Edwin Wieman.

2. Position to which nominated: Associate Director for Science, OSTP.

3. Date of Nomination: March 24, 2010.

4. Address (List current place of residence and office addresses):

Residence: Information not available to the public.

Office: Wesbrook Building #300, 6174 University Blvd, Vancouver BC V6T 1Z3, Canada.

5. Date and Place of Birth: 3/26/51; Corvallis, Oregon.

6. Provide the name, position, and place of employment for your spouse (if married) and the names and ages of your children (including stepchildren and children by a previous marriage).

Sarah L. Gilbert, Associate Director, Carl Wieman Science Education Initiative, University of British Columbia, Vancouver, BC.

7. List all college and graduate degrees. Provide year and school attended.

B.S. in Physics, 1973 MIT.

Ph.D. in Physics, 1977, Stanford University.

8. List all post-undergraduate employment, and highlight all management-level jobs held and any non-managerial jobs that relate to the position for which you are nominated. All positions involve scientific research and science education, and hence relate to the position for which I am nominated.

Assistant Research Scientist, Department of Physics, University of Michigan, 1977–1979.

Assistant Professor of Physics, University of Michigan, 1979–84.

Associate Professor of Physics, University of Colorado, 1984–87.

Fellow, JILA, 1985 to present.

Professor of Physics, University of Colorado, 1987–1997.

Chair, JILA, 1993–1995. JILA is highly successful 250+ person interdisciplinary research institute. From 1990 until 2006 I was the Principal Investigator for the JILA NSF center grant, which was by far the largest single grant of the institute and a large fraction of its total funding, and so I was the de facto, although unofficial, head during that period.

Distinguished Professor, University of Colorado, 1997 to present.

Director, Science Education Initiative, University of Colorado, 12/2005 to present.

Professor of Physics, University of British Columbia, 2007 to present.

Director, Carl Wieman Science Education Initiative, University of British Columbia, 2007 to present.

9. Attach a copy of your resume. A copy is attached.

10. List any advisory, consultative, honorary, or other part-time service or positions with Federal, State, or local governments, other than those listed above, within the last 5 years.

Colorado blue ribbon panel on high school-college alignment 2005.

I was the founding Chair of the National Academy of Science/National Research Council, Board on Science Education 1995 to 2009, and I continue to serve on that

Board as a member. This Board was frequently called upon by the Federal Government to provide consultation and objective guidance on science education.

11. List all positions held as an officer, director, trustee, partner, proprietor, agent, representative, or consultant of any corporation, company, firm, partnership, or other business, enterprise, educational, or other institution within the last 5 years.

National Math Science Initiative Dallas, Texas	Serve on the Board of Directors.	Nonprofit advancing math and science education	4/09 to present
Research Corporation for Science Advancement Tucson, AZ	Serve on the Advisory Board.	Nonprofit foundation supporting science research and education	11/08 to present
Center for Excellence in Math and Science Education of King Saud University, King Saud University Riyadh, Saudi Arabia	Chair the International Advisory Board.	Center at a university devoted to improving math and science education in Saudi Arabia	4/09 to present
American Physical Society American Center for Physics College Park, MD	Chair of the Editorial Advisory Board of "Physics Review: Physics Education Research" of the American Physical Society	Physics Professional and Educational Society	6/05 to present

12. Please list each membership you have had during the past 10 years or currently hold with any civic, social, charitable, educational, political, professional, fraternal, benevolent or religious organization, private club, or other membership organization. Include dates of membership and any positions you have held with any organization. Please note whether any such club or organization restricts membership on the basis of sex, race, color, religion, national origin, age, or handicap.

Member of the following professional societies	Location	Date of membership
American Physical Society I was the Vice-Chair and then the Chair of the Division of Atomic, Molecular, and Optical Physics in ~1990. I currently am the Chair of the Editorial Advisory Board of "Physics Review: Physics Education Research" of the American Physical Society	U.S.	~35 years ago to present
National Academy of Education	U.S.	2008 to present
Canadian Assoc. of Physicists, member	Canada	2007 to present
Optical Society of America	U.S.	~35 years ago to present
American Academy of Arts and Science	U.S.	1998 to present
National Academy of Science, Member	U.S.	1995 to present
Founding Chair of the National Academy of Science/National Research Council, Board on Science Education. I currently serve as a member.	U.S.	1995 to present
American Association of Physics Teachers	U.S.	~10 years ago to present
European Academy of Sciences	Europe	2004 to present

Membership to the National Academy of Education, the National Academy of Sciences, the American Academy of Arts and Science, and the European Academy of Sciences is by election, based on academic credentials only. Membership in the other organizations is unrestricted.

13. Have you ever been a candidate for and/or held a public office (elected, nonelected, or appointed)? If so, indicate whether any campaign has any outstanding debt, the amount, and whether you are personally liable for that debt: No.

14. Itemize all political contributions to any individual, campaign organization, political party, political action committee, or similar entity of $500 or more for the past 10 years. Also list all offices you have held with, and services rendered to, a state or national political party or election committee during the same period.

I have held no offices. My political contributions are listed below:

2/26/2000	National Committee For Effective Congress (NCEC)	$600
5/30/2000	NCEC	$500
8/26/2000	NCEC	$500
2/17/2001	NCEC	$600
6/4/2001	NCEC	$500
9/8/2001	NCEC	$600
2/9/2002	NCEC	$600
4/20/2002	Mark Udall for Congress	$500
5/11/2002	NCEC	$600
8/24/2002	Strickland for Colorado	$500
9/7/2002	Rush Holt for Congress	$500
9/13/2002	NCEC	$600
10/14/2002	Colorado Democratic Victory Fund	$500
10/14/2002	Strickland for Colorado	$500
10/15/2002	NCEC	$500
2/15/2003	NCEC	$600
4/19/2003	Mark Udall for Congress	$500
5/17/2003	NCEC	$600
8/23/2003	Democratic National Committee	$500
9/20/2003	NCEC	$600
11/22/2003	League of Conservation Voters	$400
12/22/2003	NCEC	$600
1/10/2004	Democratic National Committee	$500
2/7/2004	NCEC	$600
3/13/2004	Colorado Democratic Victory Fund	$500
4/10/2004	John Kerry for President	$500
5/22/2004	NCEC	$600
7/10/2004	Democratic National Committee	$500
8/7/2004	Democratic Senate Campaign Fund	$500
8/7/2004	House Majority Project	$500
8/8/2004	NCEC	$500
8/21/2004	Matsunaka for Congress	$500
9/4/2004	Dave Thomas for Congress	$500
9/11/2004	Colorado Democratic Victory Fund	$500
9/28/2004	Democratic National Committee	$1,000
10/10/2004	League of Conservation Voters	$600
10/10/2004	Salazar For Senate	$1,000
10/10/2004	Matsunaka For Congress	$500
10/10/2004	Colorado Democratic Senate Campaign Fund	$500
10/18/2004	NCEC	$1,000
1/8/2005	Democratic National Committee	$500
2/5/2005	NCEC	$600
3/5/2005	Colorado Democratic Victory Fund	$500
5/28/2005	NCEC	$600
7/16/2005	Democratic National Committee	$500
8/27/2005	NCEC	$500
9/17/2005	League of Conservation Voters	$500
10/30/2005	Mark Udall for Congress	$500
11/11/2005	Democratic Senatorial Campaign Committee	$500
12/10/2005	Democratic Senate Campaign Fund	$500
1/7/2006	Democratic National Committee	$500
2/4/2006	NCEC	$1,000
3/4/2006	Colorado Democratic Victory Fund	$500
3/4/2006	House Majority Project	$500
9/23/2006	League of Conservation Voters	$1,000
9/23/2006	Dem Sen Cmp Cmm Dirct MA	$500
9/24/2006	Bill Ritter For Governor	$500
9/28/2006	National Committee For Effective Congress	$1,500
8/8/2007	NCEC	$2,000
8/9/2007	League of Conservation Voters	$1,000
8/9/2007	Democratic Senatorial Campaign Committee (DSCC)	$1,000
10/3/2007	Democratic National Committee	$1,000
12/18/2007	Bill Foster For Congress	$500
7/10/2008	Fitz-Gerald For Congress	$500
8/12/2008	NCEC	$2,000
8/12/2008	League of Conservation Voters	$1,000
8/12/2008	DSCC	$1,000
8/12/2008	Democratic National Committee	$1,000
10/8/2008	Udall For Colorado	$500
10/8/2008	NCEC	$1,000
10/10/2008	Obama For America	$1,000
8/5/2009	NCEC	$2,000
8/5/2009	League of Conservation Voters	$1,000
8/5/2009	DSCC	$500
8/5/2009	Democratic National Committee	$1,000

15. List all scholarships, fellowships, honorary degrees, honorary society memberships, military medals, and any other special recognition for outstanding service or achievements.

Honors and Awards

1. Physics Research

E.O. Lawrence Award in Physics (DOE), 1993
Davisson-Germer Prize (APS), 1994
Einstein Medal for Laser Science (Society for Opt. and Quant. Elect.), 1995
Richtmyer Memorial Lecture Award (Am. Assoc. of Physics Teachers), 1996
Fritz London Prize in Low Temperature Physics, 1996 (IUPAP)
Newcomb Cleveland Prize (AAAS), 1996
King Faisal International Prize for Science, 1997
Award for Science (Bonfils-Stanton Foundation), 1997
Lorentz Medal (Royal Netherlands Academy of Arts and Sciences), 1998
R. W. Wood Prize (Optical Society of America), 1999
Schawlow Prize for Laser Science (American Physical Society), 1999
Benjamin Franklin Medal in Physics (Franklin Institute), 2000
Nobel Prize in Physics, 2001

> Nobel Prize Citation: "For the achievement of Bose-Einstein condensation in dilute gases of alkali atoms, and for early fundamental studies of the properties of the condensates"

Vollum Award for Distinguished Accomplishment in Science and Technology, Reed College, 2009

2. Education

NSF Director's Award for Distinguished Teaching Scholars, 2001
Presidential Teaching Scholar, University of Colorado, 2004
U.S. Professor of the Year, the Carnegie Foundation for the Advancement of Teaching and the Council for Advancement and Support of Education, 2004
MERLOT Editor's Choice Award for Exemplary Online Resources, 2006
Oersted Medal, American Association of Physics Teachers, 2007

3. Honorary Memberships and Fellowships

National Academy of Sciences, elected 1995
American Academy of Arts & Sciences, elected 1998
European Academy of Sciences, elected 2004
National Academy of Education, elected 2008
Hertz Foundation Fellow, 1973–1977
Sloan Research Fellowship, 1984
Guggenheim Fellowship, 1990–1991
Fellow of the American Physical Society, 1990
Distinguished Research Lectureship (University of Colorado), 1996–97
Frew Fellowship (Australian Academy of Science), 1998
Cherwell-Simon Lecturer, (Oxford University), 1999
Phi Beta Kappa Society Visiting Scholar, 1999–2000

4. Honorary Degrees

Doctorate of Science (Honorary), University of Chicago, 1997
Doctorate of Science (Honorary), Ohio State, 2005
Doctorate of Science (Honorary), Willamette University, 2007
Doctorate of Science (Honorary), North Carolina State University, 2008

16. Please list each book, article, column, or publication you have authored, individually or with others. Also list any speeches that you have given on topics relevant to the position for which you have been nominated. Do not attach copies of these publications unless otherwise instructed.

See attached lists of publications (in my C.V.) and speeches.

The speeches are primarily lectures on various aspects of physics and science education. These lists include all the publications and speeches I could find through a review of my records.

17. Please identify each instance in which you have testified orally or in writing before Congress in a governmental or non-governmental capacity and specify the date and subject matter of each testimony.

Testified before the Research and Education Subcommittee of the House Committee on Science and Technology on March 7, 2002 and March 15, 2006. Both times the subject matter was science education.

18. Given the current mission, major programs, and major operational objectives of the department/agency to which you have been nominated, what in your background or employment experience do you believe affirmatively qualifies you for appointment to the position for which you have been nominated, and why do you wish to serve in that position?

The Associate Director for Science needs to provide advice that will preserve and enhance the scientific research base of the country and the scientific work force. My experiences as a highly successful research scientist, director of a substantial research lab, and as a long time science educator qualify me for that position. An important component of this position will also be to implement the administration's desire to provide a high quality STEM education for all students. In addition to my research career in science, I have worked extensively in STEM education research, and I served as the Founding Chair and long-time member of the National Academy of Science/National Research Council, Board on Science Education. In these positions I have acquired expertise and knowledge on all aspects of STEM education and how it can be improved, and my work in this area has been widely recognized.

19 .What do you believe are your responsibilities, if confirmed, to ensure that the department/agency has proper management and accounting controls, and what experience do you have in managing a large organization?

I will have the general responsibility shared by every Federal employee to ensure that government funds are being used in the most effective and efficient way possible. This responsibility applies both to the internal OSTP work and the broader OSTP mission to ensure that agency and department programs are being coordinated and executed appropriately. However, if confirmed as an OSTP Associate Director, I will have limited direct responsibility for general management and accounting controls at OSTP, as those are primarily handled by the Operations Manager, Deputy Chief of Staff and Chief of Staff. I will assist in implementing those agency controls. I will have direct responsibility for my own staff of Policy Analysts, Senior Policy Analysts and Assistant Directors should I be confirmed.

I have experience in managing organizations that are small by Federal Government standards, but are comparable to OSTP and relatively large relative to the component of OSTP that I will oversee if confirmed. For most of the past 20 years I was in charge of a multimillion dollar NSF grant that supported the work of approximately 100 researchers and staff. I was responsible for ensuring that they followed proper management and spending and accounting practices, and I was responsible for setting overall research goals and making programmatic funding decisions. I also served a two-year term as Chair of JILA, a joint federal-state research institution with a staff of about 250. Since my NSF grant was by far the largest grant supporting JILA, even when not Chair I had ongoing de facto management responsibilities for the institute as a whole.

20. What do you believe to be the top three challenges facing the department/agency, and why?

I believe that the biggest challenge facing OSTP is simply the scale of its mandate. It is charged to advise the President on all aspects of science and technology relevant to the country. In modern society that mandate becomes ever larger and more important as science and technology both grows in scope and plays an increasingly large role in such broad issues as the economy, national security, health, meeting growing energy demands, and protection of the environment. Good advice on enhancing the vitality and value of S & T in the country needs to not only include all aspects of research and development, but also education and the technical workforce that are at the heart of a vibrant economy and a vibrant creative S & T enterprise. Evaluating and coordinating scientific and technological efforts, developing budgets, performing studies and analysis, etc. across this vast mandate is a great challenge. Such a mandate requires seeking out the expertise and wisdom of a large range of scientifically and technically excellent people, both inside and outside the government.

The second challenge I see is finding effective means to impact policies and actions in ways that are beneficial to the Nation. The OSTP does not have great authority or control of budgets, and so its tools for achieving action are limited. Its

primary tool is the development of persuasive arguments that convince people to move in the right direction. That is not easy, particularly when bold rapid action is needed.

The third challenge is to develop and maintain suitable relationships across the full span of relevant Federal agencies and organizations and nongovernmental entities to ensure first, that we hear all the voices in the broad S & T discussion, and second, we are present in important policy discussions to provide useful advice. The breadth of the OSTP mandate and the limitations of its means to have an impact make it both challenging and essential to establish these relationships.

B. POTENTIAL CONFLICTS OF INTEREST

1. Describe all financial arrangements, deferred compensation agreements, and other continuing dealings with business associates, clients, or customers. Please include information related to retirement accounts.

If confirmed, I will take an unpaid leave of absence from my position as Professor at the University of British Columbia and an unpaid leave of absence from my position as Professor at the University of Colorado.

Upon confirmation, I will resign my position as Director of the Carl Wieman Science Education Initiative at the UBC and as Director of the Science Education Initiative at University of Colorado. I will maintain my UBC pension plan and my TIAA–CREF retirement plan through the University of Colorado.

2. Do you have any commitments or agreements, formal or informal, to maintain employment, affiliation, or practice with any business, association or other organization during your appointment? If so, please explain.

If confirmed, I will take an unpaid leave of absence from my position as Professor at the University of British Columbia and an unpaid leave of absence from my position as Professor at the University of Colorado.

Indicate any investments, obligations, liabilities, or other relationships which could involve potential conflicts of interest in the position to which you have been nominated.

In connection with the nomination process, I have consulted with the Office of Government Ethics and OSTP's designated agency ethics official to identify potential conflicts of interest. Any potential conflicts of interest will be resolved in accordance with the terms of an ethics agreement that I have entered into with the Department's designated agency ethics official and that has been provided to this committee. I am not aware of any other potential conflicts of interest.

3. Describe any business relationship, dealing, or financial transaction which you have had during the last 10 years, whether for yourself, on behalf of a client, or acting as an agent, that could in any way constitute or result in a possible conflict of interest in the position to which you have been nominated: None.

4. Describe any activity during the past 10 years in which you have been engaged for the purpose of directly or indirectly influencing the passage, defeat, or modification of any legislation or affecting the administration and execution of law or public policy.

I wrote a few OpEd pieces encouraging support for legislation to provide greater support for science research and science education.

5. Explain how you will resolve any potential conflict of interest, including any that may be disclosed by your responses to the above items.

Any potential conflicts of interest will be resolved in accordance with the terms of an ethics agreement that I have entered into with the Department's designated agency ethics official and that has been provided to this committee.

C. LEGAL MATTERS

1. Have you ever been disciplined or cited for a breach of ethics by, or been the subject of a complaint to any court, administrative agency, professional association, disciplinary committee, or other professional group? If so, please explain.

I have never been disciplined or cited for a breach of ethics or been the subject of such a complaint. However, earlier this year an audit at the University of Colorado questioned $2,200 I had authorized to be spent in connection with the Science Education Initiative that I direct. These funds came from an account that had been endowed by a donor to the University, and it was my understanding that the funds were for my unrestricted use. According to the Chancellor of the University, the audit determined that—while I am generally free to use the funds as I see fit—they are still subject to the University's general policies because they were dispersed through the University's financial system. The audit identified $2,200 that was spent on services not reimbursable under University policy (out of a total of over $300,000 that I have donated to University projects from this account). The Chan-

cellor has assured me that the University has determined that I had in no way intentionally misused any funds nor did I obtain any personal gain, and has taken no further action. I have since taken a training course on the University's fiscal certification to avoid any such misunderstandings in the future.

2. Have you ever been investigated, arrested, charged, or held by any Federal, State, or other law enforcement authority of any Federal, State, county, or municipal entity, other than for a minor traffic offense? If so, please explain: No.

3. Have you or any business of which you are or were an officer ever been involved as a party in an administrative agency proceeding or civil litigation? If so, please explain: No.

4. Have you ever been convicted (including pleas of guilty or *nolo contendere*) of any criminal violation other than a minor traffic offense? If so, please explain: No.

5. Have you ever been accused, formally or informally, of sexual harassment or discrimination on the basis of sex, race, religion, or any other basis? If so, please explain: No.

6. Please advise the Committee of any additional information, favorable or unfavorable, which you feel should be disclosed in connection with your nomination: None.

D. RELATIONSHIP WITH COMMITTEE

1. Will you ensure that your department/agency complies with deadlines for information set by Congressional committees? Yes

2. Will you ensure that your department/agency does whatever it can to protect Congressional witnesses and whistle blowers from reprisal for their testimony and disclosures? Yes.

3. Will you cooperate in providing the Committee with requested witnesses, including technical experts and career employees, with firsthand knowledge of matters of interest to the Committee? Yes.

4. Are you willing to appear and testify before any duly constituted committee of the Congress on such occasions as you may be reasonably requested to do so? Yes.

RESUME OF CARL EDWIN WIEMAN

Address

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Vancouver, BC V6T 1Z3

Personal

Born March 26, 1951, Corvallis, Oregon

Degrees

Bachelor of Science, Massachusetts Institute of Technology, 1973

Ph.D., Stanford University, 1977

Appointments

Assistant Research Scientist, Department of Physics, University of Michigan, 1977–1979

Assistant Professor of Physics, University of Michigan, 1979–84

Associate Professor of Physics, University of Colorado, 1984–87

Fellow, JILA, 1985 to present

Professor of Physics, University of Colorado, 1987–1997

Chair, JILA, 1993–1995

Distinguished Professor, University of Colorado, 1997 to present

Director, Science Education Initiative, University of Colorado, 2006 to present

Professor of Physics, University of British Columbia, 2007 to present

Director, Carl Wieman Science Education Initiative, University of British Columbia, 2007 to present

Current Major Service Positions

Chair, Editorial Advisory Board, "Physics Review: Physics Education Research" of the American Physical Society

Member, National Academy of Science/National Research Council Board on Science Education, (Founding Chair, 2004–2009)

Member, Advisory Board, National Math and Science Initiative

Member, Presidential Advisory Board, Research Corporation for Science Advancement Chair, Advisory Board, Excellence Centre for Science and Mathematics Education, King Saud University, Saudi Arabia

Honors and Awards

Physics Research

E.O. Lawrence Award in Physics (DOE), 1993

Davisson-Germer Prize (APS) 1994

Einstein Medal for Laser Science (Society for Opt. and Quant. Elect.), 1995

Richtmyer Memorial Lecture Award (Am. Assoc. of Physics Teachers), 1996

Fritz London Prize in Low Temperature Physics, 1996 (IUPAP)

Newcomb Cleveland Prize (AAAS), 1996

King Faisal International Prize for Science, 1997

Award for Science (Bonfils-Stanton Foundation), 1997

Lorentz Medal (Royal Netherlands Academy of Arts and Sciences), 1998

R. W. Wood Prize (Optical Society of America), 1999

Schawlow Prize for Laser Science (American Physical Society), 1999

Benjamin Franklin Medal in Physics (Franklin Institute), 2000

Nobel Prize in Physics, 2001

> Nobel Prize Citation: "For the achievement of Bose-Einstein condensation in dilute gases of alkali atoms, and for early fundamental studies of the properties of the condensates"

Vollum Award for Distinguished Accomplishment in Science and Technology, Reed College, 2009

Education

NSF Director's Award for Distinguished Teaching Scholars, 2001

Presidential Teaching Scholar, University of Colorado, 2004

U.S. Professor of the Year, the Carnegie Foundation for the Advancement of Teaching and the Council for Advancement and Support of Education, 2004

MERLOT Editor's Choice Award for Exemplary Online Resources, 2006

Oersted Medal, American Association of Physics Teachers, 2007

Honorary Memberships and Fellowships

National Academy of Sciences, elected 1995

American Academy of Arts & Sciences, elected 1998

European Academy of Sciences, elected 2004

National Academy of Education, elected 2008

Hertz Foundation Fellow, 1973–1977

Sloan Research Fellowship, 1984

Guggenheim Fellowship, 1990–1991

Fellow of the American Physical Society, 1990

Distinguished Research Lectureship, 1996–97 (University of Colorado)

Frew Fellowship (Australian Academy of Science), 1998

Cherwell-Simon Lecturer, (Oxford University), 1999

Phi Beta Kappa Society Visiting Scholar, 1999–2000

Honorary Degrees

Doctorate of Science (Honorary), University of Chicago, 1997

Doctorate of Science (Honorary), Ohio State, 2005

Doctorate of Science (Honorary), Willamette University, 2007

Doctorate of Science (Honorary), North Carolina State University, 2008

Professional Associations

Optical Society of America
American Physical Society
American Association of Physics Teachers
Canadian Association of Physicists
National Academy of Science
National Academy of Education

Patents

S. Chu, W. Swann and C. Wieman, "Frequency standard using an atomic fountain of optically trapped atoms," Patent #5,338,930, August 16, 1994.

M. S. E. Stephens, P. A. Roos, C. E. Wieman and E. A. Cornell, "Laser sensor using optical feedback-induced frequency modulation," Patent #5,808,743, September 15, 1998.

C. E. Wieman, Z.-T. Lu, K. L. Corwin and C. Hand, "Stable Wavelength Diode Laser using the Zeeman Shift in an Atomic Vapor," Patent #6,009,111, December 28, 1999.

Publications

1. T. W. Hansch, S. A. Lee, R. Wallenstein and C. Wieman, "Doppler-free two-photon spectroscopy of hydrogen 1s–2s," Phys. Rev. Lett. *34,* 307 (1975).
2. B. Brown, G. Henry, R. Keopcke and C. Wieman, "High-resolution measurement of the response of an isolated bubble domain to pulsed magnetic fields," IEEE Trans. Magnetics *11,* 1391 (1975).
3. C. E. Wieman and T. W. Hansch, "Doppler-free laser polarization spectroscopy," Phys. Rev. Lett. *36,* 1170 (1976).
4. R. Feinberg, T. Hansch, A. Schawlow, R. Teets and C. Wieman, "Laser polarization spectroscopy of atoms and molecules," Opt. Comm. *18,* 227 (1976).
5. Wieman and T. Hansch, "Precision measurement of the ground state Lamb shift in hydrogen and deuterium," in *Laser Spectroscopy III, Proceedings of the Third International Conference*, Jackson Lake Lodge, Wyoming, USA (J. L. Hall and J. L. Carlsten, Eds., Springer-Verlag), 39–43 (1977).
6. R. Teets and C. Wieman, "Polarization spectroscopy," Focus on Science (Coherent Radiation) *1,* 1 (1977).
7. C. E. Wieman, "Search for parity violation in atomic hydrogen," in *Proceedings of the 1979 Cargese Workshop on Neutral Current Interactions in Atoms* (W. L. Williams, Ed., 1980).
8. C. E. Wieman and T. W. Hansch, "Precision measurement on the 1s Lamb shift and of the 1s–2s isotope shift of H and D," Phys. Rev. A *22,* 192 (1980).
9. D. Shiner and C. E. Wieman, "Current work on two photon excitation in a hydrogen beam for measurement of the Rydberg constant and me/mp," in *Precision Measurement and Fundamental Constants II* (B. N. Taylor and W. D. Phillips, Eds., Natl. Bur. Stand. Spec. Publ. 617, 1984).
10. S. L. Gilbert and C. E. Wieman, "An easily constructed high vacuum valve," Rev. Sci. Instr. *53,* 1627 (1982).
11. C. E. Wieman and S. L. Gilbert, "Laser frequency stabilization using mode interference from a reflecting reference interferometer," Opt. Lett. *7,* 480 (1982).
12. S. L. Gilbert, R. Watts and C. E. Wieman, "Hyperfine structure measurement of the 7s state of cesium," Phys. Rev. A *27,* 581 (1983).
13. R. N. Watts, S. L. Gilbert and C. E. Wieman, "Precision measurement of the Stark shift of the 6s–7s transition in atomic cesium," Phys. Rev. A *27,* 2769 (1983).
14. C. E. Wieman, "Lineshapes in nonlinear spectroscopy," in *Quantum Metrology and Fundamental Constants* (G. Cutler and A. Lucas, Eds., Plenum Press, 1983).
15. C. E. Wieman, "Laser spectroscopy of hydrogen and the measurement of the fundamental constants," in *Quantum Metrology and Fundamental Constants* (G. Cutler and A. Lucas, Eds., Plenum Press, 1983).
16. C. E. Wieman, "Polarization spectroscopy," in *Laser Based Ultrasensitive Spectroscopy* (R. A. Keller, Ed., SPIE Press, 1983).
17. S. L. Gilbert, R. N. Watts and C. E. Wieman, "Measurement of the 6s→7s M1 transition in cesium with the use of crossed electric and magnetic fields," Phys. Rev. A *29,* 137 (1984).
18. S. L. Gilbert, M. C. Noecker, and C. E. Wieman, "Absolute measurement of the photoionization cross section of the excited 7s state of cesium," Phys. Rev. A *29,* 3150 (1984).

19. R. N. Watts and C. E. Wieman, "Stopping atoms with diode lasers," in *Laser Spectroscopy VII, Proceedings of the Seventh International Conference*, Hawaii, June 24–28, 1985 (T. W. Hansch and Y. R. Shen, Eds., Springer-Verlag, 1985), pp. 20–21.

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22. R. N. Watts and C. E. Wieman, "The production of a highly polarized atomic cesium beam," Opt. Comm. *57,* 45 (1986).

23. R. N. Watts and C. E. Wieman, "Manipulating atomic velocities using diode lasers," Opt. Lett. *11,* 291 (1986).

24. S. L. Gilbert and C. E. Wieman, "Atomic-beam measurement of parity nonconservation in cesium," Phys. Rev. A *34,* 792 (1986).

25. D. E. Pritchard, E. L. Raab, V. Bagnato, R. N. Watts and C. E. Wieman, "Light traps using spontaneous forces," Phys. Rev. Lett. *57,* 310 (1986).

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32. D. Sesko, C. G. Fan and C. E. Wieman, "Production of a cold atomic vapor using diode-laser cooling," J. Opt. Soc. Am. B *5,* 1225 (1988).

33. C. E. Tanner and C. E. Wieman, "Precision measurement of the Stark shift in the $6S_{1/2} \rightarrow 6P_{3/2}$ cesium transition using a frequency-stabilized laser diode," Phys. Rev. A *38,* 162 (1988).

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44. T. Walker, D. Sesko and C. Wieman, "Collective behavior of optically trapped neutral atoms," Phys. Rev. Lett. *64,* pp. 408–411 (1990).

45. T. G. Walker, D. W. Sesko, C. Monroe and C. Wieman, "Collisional loss mechanisms in light-force atom traps," in *Proceedings, Sixteenth International Conference on the Physics of Electronic and Atomic Collisions*, (A. Dalgarno *et al.,* Eds., Am. Instit. Phys., New York, 1990), pp. 593–598.

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49. C. Monroe, H. Robinson and C. Wieman, "Observation of the cesium clock transition using laser-cooled atoms in a vapor cell," Opt. Lett. *16,* pp. 50–52 (1991).

50. C. Wieman, T. Walker, D. Sesko and C. Monroe, "Curious behavior of optically trapped atoms," in *Atomic Physics 12, AIP Conf Proc. 233* (J. C. Zorn and R. R. Lewis, Eds., Am. Instit. Phys., New York, 1991), pp. 58–73.

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207. C. E. Wieman, "Why Not Try a Scientific Approach to Science Education?" *Taking Stock: Research on Teaching and Learning in. Higher Education*, School of Policy Studies of Queen's University at Kingston & McGill-Queen's University Press (2010).
208. C. E. Wieman, K. K. Perkins, S. L Gilbert, "Transforming Science Education at Large Research Universities: A Case Study in Progress," Change: The Magazine of Higher Learning (March/April 2010).

209. W. K. Adams and C. E. Wieman, "Development and validation of instruments to measure learning of expert-like thinking," International Journal of Science Education *(submitted).*

210. C. E. Wieman, W. K. Adams, P. Loebelin, K. K. Perkins, "Teaching Physics Using PhET Simulations," The Physics Teachers *48,* pp. 225–227 (April 2010).

I also have written a number of publications in relationship to scientific conferences. These publications overlap with the material of the papers I listed above.

Other publications not listed above:

- Football scandal OpEd, 2/2004, *Boulder Daily Camera*.
- The Optimized University. 2006 A commissioned paper for the BC ministry of education, posted online and subsequently reprinted online in various places.
- Rebuilding Science OpEd, approximately 2002, *Rocky Mountain News* and/or *Denver Post.*
- The importance of science education OpEd, 9/2007, various Canadian papers.

Senator PRYOR. Thank you.

Let me start off here. Senator Udall, I have a few questions and I'll turn it over to you, and I may clean up unless you want to do a second round.

But first, let me start with your background. I think it's interesting that you nearly failed your first physics class. That gives hope to a lot of first year college students, I'm sure. But let me ask a question, and it may be the same question or it may be two different questions, but just for our background on the Subcommittee: Would you describe your research on atomic physics and laser spectroscopy and-or—again, it may be the same question—tell us about the Bose-Einstein—is it a condensate? Is that what it is?

Dr. WIEMAN. Condensate, yes.

Senator PRYOR. So tell us about those?

Dr. WIEMAN. OK. So they're actually somewhat different things. For many years I carried out an extensive program of using laser light to probe atoms and study their structure, learn about how they behave, how they interact with light, and a whole variety of ways that, if we probe more sensitively, we could understand more details about the structure of atoms.

Out of that work also, as we came to understand better about atoms and how they interacted with light, we came to understand how we could control them better as well. Part of that control meant that the scientific community—and Steve Chu was one of the leaders in this—part of that control was how you could use light to actually slow down atoms, if you did just exactly the right things.

Senator PRYOR. So light can actually change the behavior of atoms?

Dr. WIEMAN. Light can actually change them. You can think about light, laser light, as like little ping-pong balls and an atom as a bowling ball. An atom in the air here is whizzing along and you're bouncing these little particles of light off it, and they're giving it little kicks. And if the light has just the right characteristics, those lots of little kicks slow down that bowling ball atom.

It turns out a slow atom is a cold atom. So that led us to understand how you could make them much colder, you could hold them where you want them. That has technological implications. We can make better atomic clocks and things. But it also led us to realize that we could make them so slow, where we possibly could make

them so slow, using these new cooling techniques, that we could reach this kind of holy grail myth of physics which was the Bose-Einstein condensate.

This was a new form of matter that Einstein predicted way back in 1924, just looking at the basic equations of physics. But it was predicted to happen at ridiculously cold temperatures and so nobody really took it very seriously.

We figured out how to get things much, much colder than anyone had cooled atoms before, using this new laser cooling technology, and we saw that Einstein was right. This strange new material formed. It's fascinating to study. It doesn't behave like anything anybody's ever seen before, and we learned lots about quantum physics as a result of looking at it.

Senator PRYOR. Does that mean you actually stop the atom?

Dr. WIEMAN. We get them very, very, very close to being stopped.

Senator PRYOR. How does that become a new type of matter?

Dr. WIEMAN. The getting them cold doesn't make them a new type of matter. What makes them a new type of matter is, as you get things colder there are the laws of quantum physics that come into play when we get Bose condensation. People thought about matter being described by these laws of quantum physics that are important on the very, very tiny scale, but on the bigger scale these weird, bizarre quantum behaviors are never seen.

But if you get things colder, it turns out that the quantum waviness gets bigger and bigger. So if you get things so cold that the quantum waviness of one atom starts to overlap the quantum waviness of its neighbor, then instead of acting like two independent atoms any more, they turn into one gigantic quantum wave. And that's what a Bose condensate is; it's a whole bunch of atoms no longer acting like little particles that we're used to thinking about atoms as, but as this gigantic single quantum wave without any individual identities at all.

I realize that all sounds very strange and sort of weird, and it's because it is strange and weird, but that's the way nature behaves.

Senator PRYOR. Senator Udall.

Senator TOM UDALL. Thank you, Chairman Pryor.

It's very good to have you here today, Dr. Wieman, and we look forward to your work in the executive branch, especially in the teaching area. As a researcher, you relied on the NIST facility in Boulder, Colorado, to help achieve a scientific breakthrough that led to your joint Nobel Prize. NIST and our national laboratories contribute much to science and apply some of the brightest minds in the country to some of the most significant challenges facing our Nation, from fighting terrorism to achieving energy independence.

The national labs I think are really crown jewels in our country's research infrastructure. As Associate Director for Science, how would you employ the diverse knowledge and work of the national labs in your efforts to improve our Nation's competitiveness and maintain our leadership in scientific research?

Dr. WIEMAN. So I certainly agree with you on the value of national labs. As you point out, my close friend and collaborator at Cornell is a NIST employee and he brought enormous contributions to making all this work possible. And my wife actually directed a

large research group in NIST for many years. So I certainly won't disagree about their importance.

I think really, as Associate Director of OSTP if confirmed, I'd be looking to work, to support the strength and health of all of the research infrastructure in the U.S. and the national labs are a major component of that, along with the other national facilities and the research universities. But absolutely, the national labs do play a large part in that and I would see that as an important part of my responsibility, to make sure they're healthy and properly supported.

Senator TOM UDALL. Well, and we really look forward to working with you. We have two of the great national laboratories in New Mexico, Los Alamos National Laboratory and Sandia National Laboratory, that do a lot of the work that I talked about in terms of energy independence, helping the warrior out in the field, and a variety of other things.

Let me ask you a little bit about education because I know that's what you really want to focus on. You note in your testimony that you attended a tiny rural school in western Oregon and relied on a public library in a nearby town to supplement your education. My home State of New Mexico also faces significant challenges when it comes to rural schools and especially schools on tribal lands.

Do you have any thoughts on what efforts have been successful to overcome these challenges to teaching science in rural schools? Do you have any recommendations for how better broadband connectivity or access to other technologies might put students in rural schools on a more even footing with their peers in metropolitan areas? And also, I talked to you before the hearing about how you've developed techniques and protocols, I think, to teach science to children, and I'm interested in what are those protocols and how do you approach it, and especially dealing with disadvantaged students.

Dr. WIEMAN. Starting with the issue of the rural schools, I think this is a very important issue in the country as we try and look at the broader workforce and participation issues of how we can do a better job there, because it is a real challenge if you're out at a school of seven students in a grade, like I had, having a good science teacher and good science teaching there.

I actually started what's now quite a major project in developing on-line resources, interactive simulations for teaching science. I think we had about 10 million run off our website last year, so it's actually one of the major on-line education resources. We do a lot of work on research on how to make these effective, how people can learn from them.

So, I see there's tremendous potential to be tapped there, and it's something I've been quite involved in and would certainly see an important aspect of working with the Committee, if confirmed, to advance this.

I will say, though, that, just on the subject of rural schools, part of what our research shows is the same as everyone else's: that you have to have an effective teacher in the classroom, though. So I think that one of the other issues one has to be addressing is the shortage of well-qualified STEM teachers in this country, particularly in rural areas, and how we can better address that need.

Senator TOM UDALL. You really hit it on the head, I think. Thank you.

I think I'm in good shape.

Senator PRYOR. Thank you, Senator Udall.

Let me follow up on that last point. How can policymakers here in Washington improve undergraduate physics courses? How can we improve those?

Dr. WIEMAN. Well, this is something that I've been devoting, well, really quite a number of years, but the last 3 years full-time, to thinking how we can address this. I think at this point I'm willing to make the claim that we know how to do this. There's a small community, of which I count myself part of, that has been approaching the learning of science as a science and carrying out systematic research about what works and what doesn't work and why.

I think we understand now the basic principles about how to do much more effective teaching. I've got some recent experiments where we've been able to come in and redesign a course and get over a factor of two improvement compared to the way a good, qualified teacher has been doing it, and the amount of learning they've been getting.

So the real challenge now is how to get that implemented, how to do the policy of changing the practices so that all the teachers are following effective principles. I can't say that I'm ready to pronounce, do A, B, C, and D and it'll solve this. I can say that I think there are some important ideas out there. It's an area that I come to from the side of understanding what people need to do. I am not an expert on how to make policy that accomplishes that.

I can see that, if I'm confirmed to this position, this would be something I would be working with this committee and others, to figure out how to best implement the policy to achieve the results that we are now pretty convinced we know are possible, and we know how to do it. I think there are opportunities through looking carefully at how the Federal dollars are spent and the Federal programs to look carefully at what the efficiency and the effectiveness, and ask some hard questions about that and make sure that they're pursuing directions that we see are more effective.

Senator PRYOR. According to this year's Science and Engineering Indicators Report of the National Science Board, although America continues to lead in science and engineering, Asian countries are closing the gap through significantly increased investments in science and engineering, business investment, and education and infrastructure. So we may still be dominant, but it sounds like our dominance is fading.

How will you apply your knowledge in an attempt to redirect America's course and get us going in the right direction again?

Dr. WIEMAN. First, I'm not sure we're going in such a wrong direction. I think you have to look at this from the perspective, that for the Asian countries, an awful lot of what has made them successful is they've been copying us. They've been changing. If we look at their school systems they look better, but that is really at the K–12 level. There's an awful lot at the undergraduate level where we do better. We're doing better than they have in the past,

and they're copying this. And at the graduate level they're putting more money in.

So I think it's an issue of everybody's getting faster. We have to figure out how we can speed up. I think that that involves—well, realistically, we're never going to have the dominance we once did. There were world factors that just enhanced that. Everybody else is doing better now.

And it's not so terrible. Science is really a global activity. We all do better when some of us do better. But at the same time, we'd like to keep the U.S. at the cutting edge. That means looking hard at what are the gaps, where are places we really have unique strengths. We can enhance those. I think there are certainly a number of areas where the U.S. is still unprecedented, certainly, in innovation, entrepreneurial, dynamic, independent ways of thinking. The rest of the world would still love to be like we are.

But if we can provide the work force, the education, that's pushing our students to the front to build on those, I think we can do better.

Senator PRYOR. Are you familiar with the America Competes Act?

Dr. WIEMAN. Yes.

Senator PRYOR. It expires at the end of Fiscal Year 2010. What provisions of America Competes have proven to be the most successful and which programs do you think should be strengthened?

Dr. WIEMAN. Boy, that's a good question, one I'm not sure I'm yet qualified to answer. I'd have to look carefully at it.

Senator PRYOR. Sure. Well, as we go through a reauthorization, those are the kind of questions we'll be asking, basically how is it working, are there things that we need to improve or delete or change, that kind of exercise. So I hope you can help us through that as we go through.

Dr. WIEMAN. Yes, and I fully would expect to and want to do exactly that. It's just that hasn't been my day job right now, so I'm not quite ready to weigh in.

Senator PRYOR. I understand.

STEM is a program that I think has been great in a lot of ways, and NASA has been kind of a lead agency. Do you think that NASA should play a leading role with STEM?

Dr. WIEMAN. In the education aspects? I think that's unclear. The answer to that's kind of unclear. I think NASA has a kind of unique role in inspiring people. I wanted to be an astronaut when I was a child. There's something really dramatic and inspiring about rockets blasting into outer space to explore the universe. But at the same time, NASA does not bring much expertise to exactly what's really critical to achieving learning in science, engineering, and so on.

part of my work as chairing the Board on Science Education at the NRC saw this. We were charged to review NASA education programs. Out of that work, it was clear that they needed to be looking a lot harder at accountability, at how well their programs are really working and were they really being guided by the best understanding of effective STEM education.

So I think it would be probably best to have them focus on what they're really uniquely good at and the aspects of education they're

uniquely good at, but not necessarily turn everything over to them. It's getting the right balance.

Senator PRYOR. That's fair enough.

The last question I really have is about science parks. Some people call these innovation centers or business incubators. There are different words and maybe different nuances in what they are. But generally, you know what they are. They're places where science, engineering, and what-not come together and try to be innovative and get things out to the marketplace, etcetera.

I've seen first-hand in my state a science park really does some great things at the University of Arkansas. It has just been, I think, a real success story. We have a couple of other sites that are trying to get up and running in our state.

But let me ask you from your perspective, to what extent do you believe that science parks can contribute to scientific discovery and to technological advances?

Dr. WIEMAN. I think science parks can be wonderful. We've got spectacular examples. You list some in Arkansas. Silicon Valley, and Stanford, the Stanford Research Park, is a tremendous example of where it has really been uniquely powerful at both taking the fundamental research out of the lab and turning it into innovative products, and then at the same time turning those products back into the research lab.

Certainly everybody knows about the transistor and integrated electronics. But for my field of lasers, in fact, there has been a tremendous amount of work, even from my graduate school days on up, in the area of laser research turning into products through the Stanford science park. And you've got examples at many other universities.

So I think they really have demonstrated they can be tremendously valuable. I think it is important to put in a note of caution, though, because people talk a lot more about the ones that are successful. They don't talk, people don't advertise the failures, so often. And I do know there are failures of science parks, where universities or regions tried to start one up. The University of Colorado is a good example. They put a lot of money into it, but they really didn't have all the right pieces, and it just didn't pan out.

So I think, while I certainly would endorse the value of science parks, I think it's important, if one's looking at policy to advance these, to look very carefully at what elements you have to have in place to make them successful and learn from the failures in terms of making effective ones.

Senator PRYOR. I think part of the key there is recognizing your strengths and having some flexibility and the appropriate expectations. I know one of the advantages of the one that's in Fayetteville, Arkansas, at least what I hear about it, is that because the University of Arkansas is a relatively small university—it's not a huge university; it only has about maybe 16 or 17,000 students—because it is smaller, that's actually a strength because the faculty and the researchers tend to know each other, they work in closer proximity, and they say that they're better there in sharing ideas and collaborating together than some of the older, more established institutions, if that makes sense, where you kind of get your area of expertise and you're kind of so big that's all you do.

The other thing that they really focus on in Arkansas is trying to bring these ideas actually to the marketplace. So like for example, in nanotechnology, their effort there, they don't just call it nanotechnology. They like to call it "nano manufacturing," because they really want to try to get these ideas out of the lab and get them out in the marketplace.

So I know not everybody has the same mission, nor should they, because there's going to be different strengths and different roles as we do this. But I agree, I think that they can play a very significant role in trying to stimulate more scientific activity, research activity, innovation, technology.

What we're going to do, Dr. Wieman, is we're going to leave the record open until 6 p.m. tomorrow, for all the Senators and staffs who want to ask you more questions, like they want to get you to explain this Bose-Einstein thing one more time or something like that. We're going to leave it open until tomorrow evening.

So what we'd ask all the staffs to do and all the offices to do is to get those as quickly as possible over here to the Committee, and then we'll get those to you, and a rapid response would be very much appreciated.

But I want to thank you for your willingness to take on this public service and really do some great things there and play a key role in developing this policy and giving advice to the folks who need it. So I want to thank you for being here today and thank you for all the folks you brought with you.

So I thank you and we'll adjourn the hearing.

[Whereupon, at 3:31 p.m., the hearing was adjourned.]

A P P E N D I X

PREPARED STATEMENT OF HON. BILL NELSON, U.S. SENATOR FROM FLORIDA

Thank you, Mr Chairman.

Dr. Wieman, we had the opportunity to meet last month and from that conversation, as well as from your testimony here today, I can say that I'm impressed with your zeal for Science, Technology, Engineering, and Math (STEM) issues. In your written testimony you state, "Our global economy is increasingly based on science and technology. To maintain U.S. economic competitiveness and leadership in innovation, we need to also have leadership in STEM education."

Amen—as Chairman of the Science and Space Subcommittee I share your enthusiasm on this subject and couldn't agree with you more. The efforts we make in STEM education today will pay dividends in the future as the next generation of leaders comes to maturity and strives to keep the United States as the world's leader in these areas.

Today I'd like to explore these subjects with you a little further and to gain a better understanding of some of the specific actions you will take in this important role we are considering for you. I look forward to our exchange.

Thank you, Mr Chairman.

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. BILL NELSON TO CARL E. WIEMAN, PH.D.

Question 1. During the launch of the "Educate to Innovate" Campaign in November 2009, the President called for the expansion of STEM opportunities for all young people. NASA Administrator Charles Bolden has also identified STEM education as a pressing need.

In response to this need, NASA is launching the *Summer of Innovation* program to increase the scope and scale of the agency's commitment to STEM. The Summer of Innovation is designed to improve STEM teaching and learning in partnership with Federal agencies, philanthropic institutions, universities, industry, museums, nonprofit organizations, and states and localities.

Dr. Wieman, please discuss the specific actions you intend to take to meet the President's call to action regarding STEM. How will you work with NASA to ensure the Nation's space and aeronautics programs are best used to inspire and educate the nation, especially young people?

Answer. We know that too often, even students who are proficient in STEM subjects choose not to pursue them. The STEM "pipeline" narrows dramatically in the older grades, due especially to attrition of girls and minorities, and it narrows again within the first years of college. We can and must do better.

I believe NASA has unique assets that can make a significant difference in addressing this challenge. First is its ability to inspire and connect with Americans' inherent enthusiasm for discovery. As I mentioned during my hearing, I was inspired by the space program as a young boy and even wanted to be an astronaut. As the President has stated: "The space program has always captured an essential part of what it means to be an American—reaching for new heights, stretching beyond what previously did not seem possible. . . . Space exploration is not a luxury, it's not an afterthought in America's quest for a brighter future—it is an essential part of that quest." I think we can do much more to bring that spirit of discovery and imagination into every community and classroom. NASA's "Summer of Innovation" has that potential.

Question 2. In 2007 Congress passed the America COMPETES Act, landmark legislation intended to increase the Nation's investment in research and development (R&D), and in STEM education. Authorizations for the America COMPETES Act expire this year and, as we consider a reauthorization and the President's FY 2011 budget proposal, we need to evaluate the effectiveness of the programs funded by COMPETES in increasing American innovation and competitiveness.

Dr. Wieman, please comment on the COMPETES Act as implemented thus far. What changes to the Act would you recommend as we reconsider a reauthorization this year?

Answer. The America COMPETES Act provides a valuable guide to Federal policies in innovation, competitiveness, and STEM education. As with any program of this scope, a review should be welcomed: to strengthen the parts that have the most capacity to leverage the American economy and secure America's future, and to trim or amend those parts that have proven less valuable.

The original COMPETES Act identified three key science agencies—the National Science Foundation, the DOE Office of Science, and the National Institute of Standards and Technology laboratories—as essential to our Nation's future prosperity and to preserving America's place as the world leader in science and technology. I support the Administration's ongoing efforts to ensure that the doubling trajectory for these three agencies remains on track.

One critical role a review of the Federal STEM education program can do is to look carefully at the STEM education system from an overall perspective, supporting work to understand what the essential components are and how they are linked, and what is necessary for each component to make the final result most effective. Many STEM education programs are piecemeal, short-term attempts to deal with what is a complex, long-term problem. The substantial Federal investment in STEM education requires improved efficiencies and effectiveness for these investments. Congress made some attempts at this by not funding some programs in the original authorization. We should streamline duplicative programs. The reauthorization is an opportunity to articulate the highest-priority initiatives that truly have the promise of making significant impacts on innovation and competitiveness and to leave out studies, programs, or process requirements with minimal impacts or minimal prospects for funding.

If confirmed, I would work with this committee to streamline the STEM education components of the bill to ensure the maximum impact on U.S. STEM education from the Act.