Physics : Part 1: Video 1 : Introduction & Nomenclature

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Question Module Description

This module introduces six dominant modes of questioning from the perspective of computational thinking, design thinking, engineering, philosophy, science, and social sciences.

While these are not the only important disciplinary modes of investigation, these six perspectives will introduce all undergraduate students to the distinctive modes of questioning across these disciplines, and provide an initial exposure to how scholars from these disciplines pursue specific lines of questioning of everyday issues.

Scope of this Question module

It is not possible to cultivate a questioning mind within one short semester. But it is useful to make a start.

We have assembled 6 perspectives to trigger the process of thinking and questioning, using a general approach to specific disciplines to get the discussion going.

The 6 perspectives are:

Humanities – how philosophers question, what they question about

Science – how scientists investigate natural phenomena; what questions do they raise?

Computing – what is computational thinking; how to approach a problem in computing

Social Sciences – what is a social science issue; what methods are used to answer questions in Social Sciences?

Engineering – what are engineers concerned about; how do they approach their concerns?

Design – what is design thinking; what questions do designers ask?

Learning Outcomes

Students are expected to:

Demonstrate an understanding of the approach adopted by the six disciplinary perspectives introduced in this module;

Articulate the main features of each mode of investigation and;

Pursue their own line of inquiry using these modes of investigation.

It will not make you an expert but you will better appreciate the various modes of Enquiring and Questioning.

Contents

Contents in the Physics Segment

- A total of 10 short video Lectures
- 2 short enjoyable filmlets done by NUS students
- 2 Compulsory Readings
- 2 IVLE MCQ Quizzes

- 1 Pendulum Tutorial (to be done in groups)
- 1 Pseudo Science exercise to be done during Tutorial

What are our short video lectures ?

- Introduction and Nomenclature
- What is Question's role in Critical Thinking ?
- What is Science (Physics) *per* se ?
- What is Experimental Enquiry (filmlet) ?
- What is Theoretical Enquiry ?
- What is Phenomenological Enquiry ?
- What … 2 Types of knowledge about Nature (filmlet) ?
- What is Pseudoscience ?
- Concluding Remarks
- Comments on your Tutorial

Contents

What is the Question module about ?
Contents of the Physics Segment
Physics with History and Philosophy
Compulsory Readings and IVLE MCQ Quizzes
Compulsory Tutorial
Comments on Questions and Science
Summary and Appendix

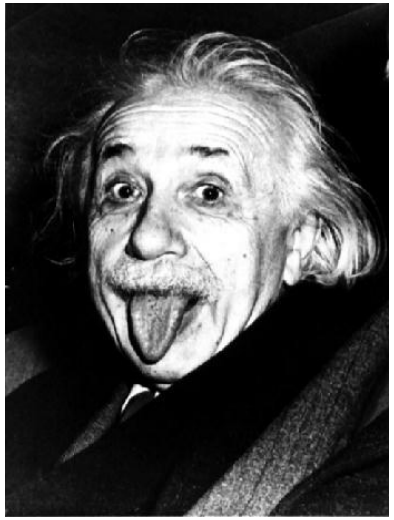
Physics with History

Furthermore, Maxwell noted the value of history of science in teaching: “The history of the development … of ideas in all subjects which we, as thinking men, take the deepest interest.”

In the lecture, Maxwell said, “It must be one of our most constant aims to maintain a living connexion between our work and the other liberal studies of Cambridge, whether literary, philosophical, historical or philosophical.” His idea of interdisciplinary study is fully consistent with the view of science education espoused today by liberal arts colleges.

Genrikh Golin, *J.C. Maxwell, A Modern Educator,* Physics Today June 2013
Gutenberg eBook (2004) : *J.C. Maxwell, Five of Maxwell’s Papers*

Physics with Philosophy



"Physics without philosophy would be **blind**; philosophy without physics would be **lame**" … this sentiment, adapting Einstein's famous comment on Science and Religion.

Physics World, 2008, P37.

Einstein on History & Philosophy

Albert Einstein was extremely interested in the philosophical conclusions of his work. He writes:

"I fully agree with you about the significance and educational value of methodology as well as history and philosophy of science. So many people today - and even professional scientists - seem to me like somebody who has seen thousands of trees but has never seen a forest. A knowledge of the historic and philosophical background gives that kind of independence from prejudices of his generation from which most scientists are suffering. This independence created by philosophical insight is - in my opinion - the mark of distinction between a mere artisan or specialist and a real seeker after truth.“

A. Einstein

Einstein's letter to Robert A. Thornton, 7 December 1944. *EA* 61-574.

Philosophy and Physics

"When I was nine or ten years old, Father had already observed that I was gifted in mathematics. When I reached the junior high school at age eleven, my ability in this direction was quite obvious. Looking back at those days, had he taught me analytic geometry or calculus at that time, I would certainly have made rapid headway which would probably have greatly pleased him. *But he did nothing of this sort*.

During the summer vacation between grades seven and eight, I was instead coached by a Mr. Ding Zeliang, who was a student in the history Department of Tsing Hua University.

C.N. Yang, *Father and I*, Inst. Adv. Studies Supp. Newsletter, NTU (2013) P49-63
Nobel Laureate 1957, The Chinese Hong Kong University, Hong Kong

Physics is Natural Philosophy

Good philosophy must exist, if for no other reason, because bad philosophy needs to be answered.

C. S. Lewis, Oxbridge

http://www.cslewis.org/resource/cslewis/

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Compulsory Readings (Short Essays, IVLE)

These are short essays written by well known physicists.

R. Feynman, *The Uncertainty of Science* (P3-28) in *The Meaning of it All*, 1998 Basic Book.

S. Weinberg, *The Boundaries of Scientific Knowledge* (*P70-82*) *and The Methods of Science* (P83-92) in *Facing Up*, 2001, Harvard University Press

A. Frank and M. Gleiser, *A Crisis at the Edge of Physics*, June 5 2015 The New York Times.

G. Ellis and J. Silk, *Scientific Method: Defend the Integrity of Physics*, v516 321-323 (2014) Nature

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About Reading too much !

Reading, … , diverts the mind too much from its creative pursuits.

Any man who reads too much and uses his own brain too little falls into lazy habits of thinking.

Albert Einstein

Caveat : Reading too much !

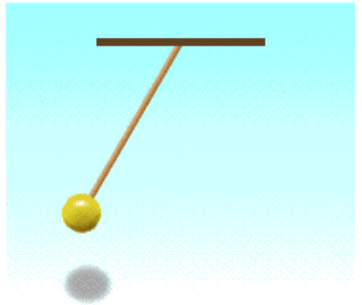
This isn't exactly the best known quote by Einstein and I doubt many teachers quote this to their students. Reading is generally a good thing, but if it starts becoming a substitute for thinking on your own it can hold you back from reaching your potential.

This quote touches on a problem that holds many people back from actually accomplishing things. It is easy to spend so much time researching that you never actually execute. That doesn't mean you shouldn't read, do research and try to learn from others, but at some point you have to decide that you've gathered enough data and the time has come to do something. That may be starting your own business, writing a book or even repainting your living room. You have a very finite lifespan. Some people spend their life preparing for what they want to do without ever actually **doing what they want to do.**

Sometimes the most helpful situations are the ones that force you to go ahead and do something by removing the option to try to collect more information.

http://www.productivity501.com/are-you-reading-too-much/8874/

About our Tutorial (Pendulum)



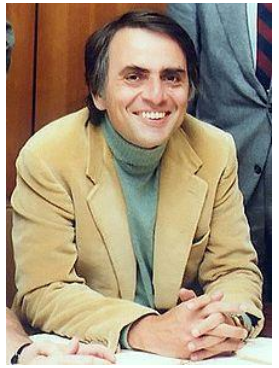
Did you ask a good question ?

Prof. Chandrasekhar (Nobel Laureate).

About our Tutorials

In science it often happens that scientists say, " you know that's a really good argument; *my position was mistaken*," and then they would actually change their minds and you never hear them talk about the old idea and they really do it. It doesn't happen as often as it should, because scientists are human and change is sometimes painful. But it happens every day. I cannot recall the last time something like that happened in politics or religion ....

Carl Sagan



Harvard / Cornell Astronomer

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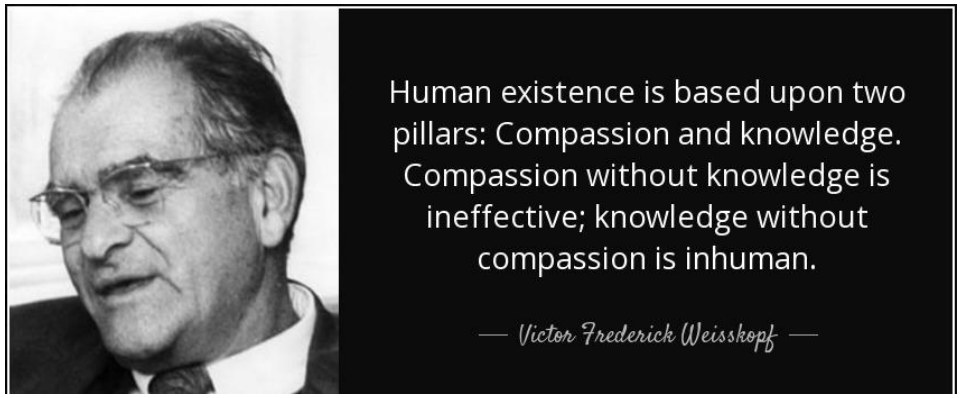
Science Education

Perhaps the best formulation I have found is this: "Quality science education contributes to a more interesting and thoughtful life by instilling a deeper awareness of what we see around us."



V. Weisskopf, *The Privilege of being a Physicist,* 1989 W.H. Freeman and Co.

Science is the opposite of Knowledge

Science is curiosity, discovering things and asking why. Why is it so? Indeed, science is the opposite of knowledge. Science asks the *why* and *how* questions and therefore is the process of questioning, not the acquisition of information. We must always begin by asking questions, not by giving answers. We must create interest in things, phenomena, and processes.

V. Weisskopf, *The Privilege of being a Physicist,* 1989 W.H. Freeman and Co.

What is Science ?

Science does not provide answers to definite questions. It is not flat knowledge, formulae, names. Richard Feynman, in an essay, relates how he came to science through his father's guidance. He and his father once went for a walk in the woods and Richard asked, "What is the name of that bird?" His father replied, "Well, I can tell it to you, but what is the use? We have one name, the Chinese another. But names are not essential. The essential things are how the bird uses its wings to fly, how and what he eats, how he gets little ones, and how he came to be in the course of evolution. That is true science."

Wrong Questions ?

We must not overlook one fact: youngsters and adults cannot learn if information is pressed into their brains. You can teach only by creating interest, by creating an urge to know. Knowledge has to be sucked into the brain, not pushed into it. First, one must create a state of mind that craves knowledge, interest, and wonder. Indeed, that's largely our duty. Then we must help children find knowledge, by hinting, guiding, evoking questions. "Wrong" questions are often more instructive than "right" ones.

Questions about Nature ?

What we observe is not nature itself, but nature exposed to our method of questioning.

W. Heisenberg

Perhaps this is what we mean by "*understanding*" nature at its most fundamental level !

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Summary :

An educated mind is never certain.

Education's purpose is to replace an empty mind with an open one. Like the parachute, it works best when it is open.

So keep an open mind and hope that you enjoy the videos.

Appendix :
What are the main Fields of Physics ?

- Classical Mechanics
- Electricity & Magnetism
- Statistical Mechanics
- Quantum Mechanics
- Space-Time Relativity
- Quantum Field Theory

C. Stevens, The 6 Core Theories of Modern Physics, 2002 MIT Press.

References: Interesting Readings 1

M. Brooks, *The Big Questions in Physics*, 2011 Quercus Press.

T. Crilly, *The Big Questions in Mathematics*, 2011 Quercus Press.

R. Feynman, *The relation of Mathematics to Physics* (P35-58) in *The Character of Physical Law,* 1998 Basic Book.

V. Weisskopf, *The Privilege of being a Physicist,* 1989 W.H. Freeman & Co.

References: Interesting Readings 2

G. Polya, John H. Conway (Foreword): *How to Solve It: A New Aspect of Mathematical Method,* 2004 Princeton Press.

J. Carr, *The Art of Science*, 1996, High Text

E. Burger & Michael Starbird, *Five Elements of Effective Thinking* 2012, Princeton U Press.

Widening circle of Awareness

A human being is a part of the whole, called “Universe” by us, a part limited in time and space. He experiences himself, his thoughts and feelings, as something separated from the rest – a kind of optical delusion of his consciousness. This delusion is a kind of prison for us, restricting us to our personal desires and to affection for a few persons nearest to us. Our task must be to free ourselves from this prison by widening our circle of compassion to embrace all living creatures and the whole nature in its beauty. Nobody is able to achieve this completely, but the striving for such achievement is in itself a part of the liberation and a foundation for inner security.

A. Einstein (Nobel Laureate)