

**Some Background on the movie/play "COPENHAGEN" by Michael Frayn**

**CHARACTERS:**

Neils Bohr..... Stephen Rea  
Margrethe Bohr (Neils' wife)..... Francesca Annis  
Werner Heisenberg..... Daniel Craig

In what has been called one of the great scientific and literary treatises of the pre-Newtonian Age of physics, Galileo's "DIALOGUE ON THE TWO WORLD SYSTEMS" was written as a play consisting of three fictitious characters discussing the viability of the two contrary views of the universe. Two characters presented their arguments (one defending the Earth-centered theory, and the other countering with the sun-centered view), and a third person was used as an objective arbitrator - swayed by the more convincing argument. (Of course, Galileo used this popular vehicle to promote his strongly- Copernican view.)

In Michael Frayn's play *COPENHAGEN*, there are also three characters - however the similarity ends there. His characters are real people: Neils Bohr, who we have studied in class as one of the leading architects of modern atomic physics and quantum theory, his wife Margrethe, and Werner Heisenberg, one of Bohr's students, and also a co-founder of quantum mechanics, best know for his "Uncertainty Principle."

In 1941, after having their friendship interrupted by World War II, Heisenberg set off to Denmark to visit with his old friend and mentor. What, precisely, took place at this rendezvous has been debated for over sixty years by scientists, philosophers of science, historians and even laymen.

This play is a re-enactment of this meeting, as imagined by Michael Frayn, based on existing historical documents and interviews. Many of the discussions *could* have taken place, in some form or other. Of course, only Bohr and Heisenberg could say for sure. Both are long since deceased. Like the third character in Galileo's *DIALOGUE*, Bohr's wife becomes the objective arbitrator who is able to step back from the emotional situation and to see both men clearly (although she is, on occasion, prone to present her own interpretation of their dialogue and body language).

**SOME HISTORICAL BACKGROUND:**

The Bohr-Heisenberg relationship began in the 1920's. Bohr, of course, was by this time an internationally-known and respected physicist who had set up his "Copenhagen Institute" as a kind of think-tank, drawing the most brilliant and innovative minds of the early 20th century in his home country of Denmark. Heisenberg would be one of his star pupils who would eventually become known as Germany's greatest physicist of the mid 20th century. The two men had a type of father-son relationship prior to World War II. The war would change all of that.

Although never joining the Nazi party, Heisenberg felt a strong allegiance to his homeland, with the hope that Germany would once again return to the honored cultural and academic status it had during the 19th century. Unlike many other physicists who fled Germany for Russia, Great Britain or the U.S., he chose to stay with his family, and was appointed by Hitler as the head of the German research group in nuclear physics (designated to develop applications of nuclear energy, and possibly a powerful weapon as well). Bohr, half Jewish, was "trapped" in his country of Denmark, which had been occupied recently by the Nazis. He had, before the occupation, consulted with nuclear physicists at Los Alamos in the U.S.

In 1939, uprooted European physicists Leo Szillard and Albert Einstein sent a letter to President Franklin Roosevelt warning him of the imminent danger posed by the power of nuclear fission - and

the research they knew was being conducted by the Germans. This would ultimately lead to the development of the “Manhattan Project” - whose goal was to construct a nuclear-fission based bomb before Germany could.

In 1941, Heisenberg, in an unusual move, traveled to Copenhagen (at great risk) to meet with his former mentor and old friend. After that brief meeting, the friendship ended.

This is the story of what “*could* have been said” at that meeting, and the possible repercussions it had, . . .or *MAY* have had.

### **THE PHYSICS IN BRIEF:**

In order to sustain a nuclear fission reaction, a quantity of the isotope U235 must be extracted from U238 - a very difficult separation requiring much of the original material and many delicate, time consuming and very difficult procedures. U235 is susceptible to fissioning (splitting) when bombarded by high-speed neutrons. Starting the reaction produces a “chain reaction” which goes to completion in a fraction of second, releasing enormous amounts of energy. However, in order to sustain the reaction sufficiently, a certain “minimum” amount of fissionable U235 must be used.

### **ABOUT THE PLAY:**

This movie (based on a stageplay) is presented in a very unusual format. You will have to pay close attention to the setting(s) and dialogue, as the time lines flip-flop from present-day Copenhagen (with the “ghosts” of the three characters meeting each other at the now empty Bohr residence) to the actual flash-back to the 1941 meeting. However, the play presents not one, but several scenarios, each depicting a possible encounter theme - liberally doused with each character’s personal thoughts throughout the reunion. You will be taken back each time to the same starting point as Heisenberg approaches the Bohr house, rings the doorbell, and is greeted by Neils and Margrethe. Each scenario plays out to a different ending (think Quantum Theory).

### **QUESTIONS TO PONDER:**

Obviously, this is not an action-packed adventure, but a subtle, intellectual and complex drama with many layers. You should be able to follow the physics. However this play is more about interpersonal relationships interwoven in an historical context rich with overlapping storylines, moral dilemmas and great philosophical questions confronted by ordinary (some might say extraordinary) human beings faced with an awesome responsibility.

While you are watching this video **DON'T JUST SIT THERE!!!!**

Look these questions over carefully before you watch, I will give you breaks to jot down notes *after* you watch! It would be better to concentrate your full attention on the dialogue and actors.

Think carefully, watch carefully, take note of ANYTHING you see or hear, no matter how subtle. The more references to the play you can allude to, the stronger the argument you can make for your answers.

So, **GET YOUR HEAD UP OFF THAT DESK AND PAY ATTENTION!**

**General questions: All of you should be able to address these two questions.**

Why did Heisenberg go to Denmark, and what did the two men say to each other?

What happened during this pivotal meeting that was a defining moment of the modern nuclear age?

**More specific questions:** You will be divided into FIVE groups, with each group responsible for TWO of the questions below. Groups will then present their arguments to the class for discussion. Please elaborate in as much detail as possible, citing specific references from the movie! Your presentation (including your response to questions from me and the class) will count as a 100 point quiz grade.

1. Did Heisenberg come to “show himself off” as the reigning theoretical physicist in Germany, and *let* Bohr know that he had the ability to “save” him from the Nazis?
2. Did Heisenberg *expect* to find out whether the Americans were making a bomb or to get Bohr to help with the German project?
3. Did Heisenberg *intentionally delay* the German bomb project in order to prevent the Nazis from acquiring the bomb, or was the fact that they were not able to develop a bomb just a matter of not having the ability?
4. What were the moral and ethical views shared by these two brilliant physicists in the application of theoretical physics (their life’s work) to promote weapons of mass destruction?
5. How did these men view their personal roles in the war?
6. Was Heisenberg *aware of his own motivation* to confront his former teacher and friend?
7. Which scenario does the author seem to prescribe to most conspicuously? What evidence do you have to defend your answer? Which scenario appeals to *you* as the most likely? Why?
8. Draw parallels to this story in light of what is happening in the world today in Iran, North Korea and China.? Be specific.
9. How do you think Bohr and Heisenberg would react to the subsequent proliferation of nuclear weapons, and the expanding number of countries that *have* developed, *are* developing, or even *thinking* about developing nuclear bombs?
10. What would you say is Frayn’s underlying theme in this portrayal? Why? (hint: think physics)