

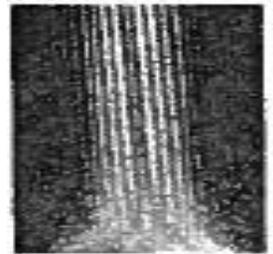
## The Challenge of Quantum Reality

Video Questions - Complete the questions below as you watch 16:55 - end of the video: The Challenge of Quantum Reality. <https://www.youtube.com/watch?v=wihrAjFXg3o>

### Measurement Disturbance

11. If we do measurements to determine which slit an electron went through, we find that:
- A) half of the electron goes through each slit.
  - B) the whole electron goes through both slits.
  - C) the whole electron goes through one slit or the other.
  - D) it is impossible to detect an electron.

12. The Tübingen experiment mentioned in the video was very subtle. Detectors were placed beneath each slit. Electrons that passed near one of the two detectors generated a tiny current in that detector. Why is the interference pattern visible at the top but not at the bottom?



### Quantum Interpretations

13. We can predict the overall behavior of the electrons in the double-slit experiment, but nobody really knows what the electrons are doing between the source and the detector.

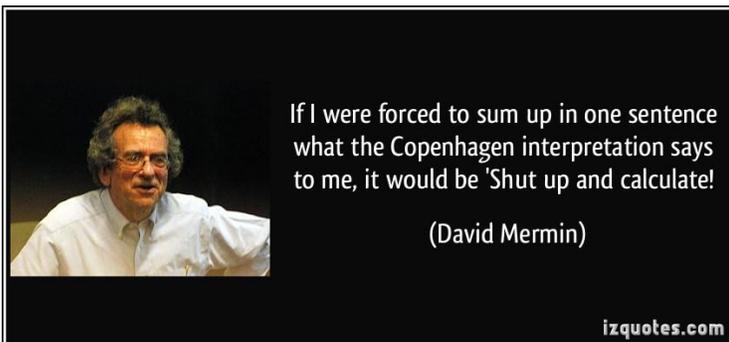
To complete the picture, physicists have proposed various interpretations, including:

#### Collapse Interpretation

- thinking of electrons as spread-out waves that collapse to point-like particles once they are measured

#### Pilot Wave Interpretation

- thinking of electrons as particles that are guided by an invisible \_\_\_\_\_



#### Many Worlds Interpretation

- thinking of \_\_\_\_\_ universes that come into being when we make measurements at the quantum level

#### Copenhagen Interpretation

- thinking exclusively about the direct results of \_\_\_\_\_.

## Quantum Applications

14. Many technologies take advantage of the wave behavior of electrons. For example: the \_\_\_\_\_ microscope which can resolve objects down to individual \_\_\_\_\_.

15. Other technologies take advantage of the particle nature of light. For example: \_\_\_\_\_, \_\_\_\_\_, and \_\_\_\_\_.

16. If you do not think quantum mechanics is important and you do not like quantum mechanics you can choose to live your life without it...But what would you be giving up?

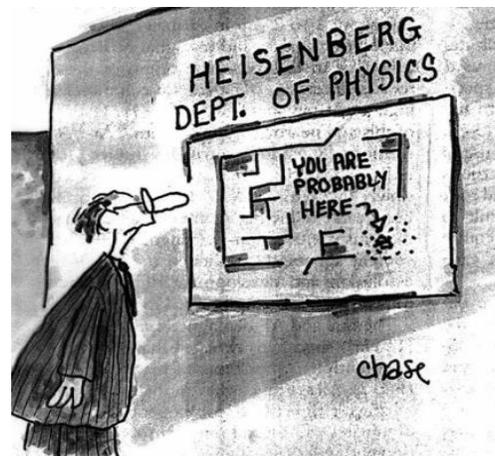
17. What is the future of quantum applications?

Video Questions - Complete the questions below as you watch the video: What is The Heisenberg Uncertainty Principle? <https://www.youtube.com/watch?v=TQKEL0E9eY4>

## Heisenberg Uncertainty Principle

18. The Heisenberg Uncertainty Principle says that you can never simultaneously know the exact \_\_\_\_\_ and the exact \_\_\_\_\_ of an object.

19. Uncertainty is often explained as a result of measurement, that the act of measuring an object's position changes its speed or vice versa. The real origin is that the Uncertainty Principle exists because everything in the universe behaves like both a \_\_\_\_\_ and a \_\_\_\_\_ at the same time.



General Analysis Questions – Answer these questions after watching the videos.

1. Read pages 634 & 635 in your text. Use this information, in addition to the video information, to answer the following questions.

- a. Why do the different interpretations of quantum mechanics exist?
  
  
  
  
  
  
  
  
  
  
- b. In which interpretation does a single electron go through one and only one slit?
  - I. Collapse
  - II. Pilot Wave
  - III. Many Worlds
  - IV. Copenhagen
  
  
  
  
  
  
  
  
  
  
- c. Which interpretation accepts that some questions cannot be answered?
  - I. Collapse
  - II. Pilot Wave
  - III. Many Worlds
  - IV. Copenhagen
  
  
  
  
  
  
  
  
  
  
- d. Which interpretation makes the most sense to you? Why?

2. Taking the Heisenberg Uncertainty Principle into account (read page 637 in text if unsure), explain whether it is possible to take exact measurements of an electron's position and momentum.