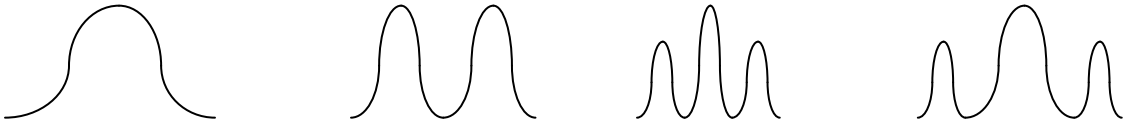
Quantum Physics Concept Questions

Wave-Particle Duality and the Double Slit Experiment

Use the following diagram for the next five questions.



a) b) c) d)

1) A **water wave** passes through two slits. Which diagram matches the amplitude of the resulting wave?
a) b) c) d)

2) A **sound wave** is directed toward two slits. Which diagram matches the loudness of the sound after the slits?
a) b) c) d)

3) A beam of **tennis balls** is fired through two slits towards a wall. Sketch the marks made by the tennis balls on the wall. Which diagram best represents the density of those marks?
a) b) c) d)

4) A beam of **light** passes through two slits towards a screen. Sketch the bright and dark fringes on the screen. Which diagram best represents the brightness?
a) b) c) d)

5) A beam of **electrons** passes through two slits and then hit a detector. Sketch what the distribution of electrons will look like. Which diagram best represents this?
a) b) c) d)

6) Particles are different from waves because particles are ...
a) spread out and generate an ____interference pattern ____in the double-slit experiment.
b) localized ____and generate an ____interference pattern ____in the double-slit experiment.
c) localized ____and generate a _____distribution ____that is the sum of each single-slit distribution.
d) spread out ___and generate a-_____distribution____ that is the sum of each single-slit distribution.

7) It is easier to see an interference pattern if the electrons:
a) travel slower b) travel faster c) speed has no effect on the pattern

8) If you compare red light to blue light, the red light:
a) is brighter _____b) is dimmer c) has less energy per photon d) has a smaller wavelength

9) Physicists working with radio waves in radar treat light as a wave and physicists working with gamma radiation from nuclear radioactive decay treat light as particles. This is because ...
a) radar was developed before radioactivity. b) radioactivity was developed before radar.
c) longer wavelengths are more localized. d) longer wavelengths show interference more easily.

10) You get sunburns from ultraviolet light but not from visible light because UV photons have a greater:

a) mass b) frequency c) speed d) wavelength

11) It is harder to see interference with buckyballs than electrons because buckyballs:

a) are neutral and harder to accelerate b) are bigger and need bigger slits
c) have smaller wavelengths d) have bigger wavelengths

12) Suppose you want to show your wave-like nature with diffraction as you walk through the doorway. How slowly would you need to move?

a) 10^{35} m/s b) 10^{15} m/s c) 10^{-15} m/s d) 10^{-35} m/s

13) Three types of particles with the same momentum – electrons, protons, neutrons - were sent toward double-slits and then detectors. Which showed the greatest spacing between nodes?

a) electrons b) protons c) neutrons d) they were all the same

14) Why have interference effects with tennis balls not been observed?

a) The de Broglie wavelength equation, $\lambda = h/p$ is only for sub-microscopic objects.
b) The experiment has not been done yet.
c) The de Broglie wavelength for a tennis ball will be much smaller than for an atom.
d) The de Broglie wavelength for a tennis ball will be larger than for an atom.

15) If we make 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 or the other slit. d) the interference pattern disappears

16) For electrons in a double-slit experiment, physicists know...

a) where an electron will hit the screen. b) which slit they went through
c) that the electron went through both slits. d) that all interpretations give the same predictions

17) There are competing ideas about what is happening between the source and the detector in the double-slit experiment. In which of the interpretations does an electron go through one and only one slit?

a) Pilot Wave and Collapse b) Pilot Wave and Many Worlds
c) Collapse and Many Worlds d) all three interpretations

18) The double-slit experiment is hard to understand because ...

a) the math is so difficult. b) the theory is still new and not fully tested.
c) you need to study it in university. d) nature does not make sense.

19) An electron microscope can produce clearer images of significantly smaller objects than a light microscope can because the electrons have a ...

a) larger frequency b) smaller size. c) slower speed. d) shorter wavelength.

20) Quantum physics was needed for the development of ...

a) computers and electron microscopes b) maglev trains and particle accelerators
c) nuclear energy and bombs d) LED's and lasers

Polarized Photons

21) A photon of unpolarized light heads toward a polarizing filter. What passes through the filter?
a) a photon b) half a photon c) nothing d) either a photon or no photon

22) A photon passed through a vertical filter and heads toward another vertical one. What passes through the second vertical filter?
a) a photon b) half a photon c) nothing d) either a photon or no photon

23) The photon next heads toward a horizontal filter. What passes through the horizontal filter?
a) a photon b) half a photon c) nothing d) either a photon or no photon

24) A photon passed through a vertical filter and then heads toward one at 45^{o}. What is the probability that the photon passes through the second filter?
a) 0% b) 12.5% c) 25% d) 50%

25) A photon is heading toward a vertical filter, then one at 45^{o}, and then a horizontal one. What is the probability that the photon passes through all three filters?
a) 0% b) 12.5% c) 25% d) 50%

Use the patterns bellow to answer the next three questions:

a) b) c)

26) A beam of laser light heads toward a double-slit. What pattern will you see on the screen?
a) b) c) d) It depends

27) A beam of laser light heads toward a double-slit. There is a vertical polarizer on one slit and a horizontal one on the other. What pattern will you see on the screen?
a) b) c) d) It depends

28) A beam of laser light heads toward a double-slit. There is a vertical polarizer on one slit and a horizontal one on the other. A third polarizer is placed after the slits. What pattern will you see on the screen?
a) b) c) d) It depends