For these questions, use the simulation "Interferometer experiments with photons, particles and waves" in the QuVis HTML5 collection.
www.st-andrews.ac.uk/physics/quvis/simulations_html5/sims/photons-particles-waves/photons-particles-waves.html

1) Have a play with the simulation for a few minutes, getting to understand the controls and displays. Note down three things about the displayed quantities that you have found out.

For questions 2-6, consider the case with just a single beamsplitter present in the experiment.

2) Compare the detection outcomes for classical particles and for electromagnetic waves. List one way in which these outcomes are similar, and one way in which they are different.

3) Explain the difference you found between classical particles and electromagnetic waves in terms of how each behaves when encountering the beamsplitter.

4) Compare the detection outcomes for single photons and for electromagnetic waves. List one way in which these outcomes are similar, and one way in which they are different.

5) How does the behaviour of a single photon encountering the beamsplitter compare with classical particles and with electromagnetic waves?

6) In terms of this experimental setup alone, is a single photon more like a classical particle or more like an electromagnetic wave? Briefly explain your answer.

For questions 7-9, consider the case with two beamsplitters present in the experiment, and no phase shifter present.

7) Compare the detection outcomes for classical particles and for electromagnetic waves. List one way in which these outcomes are similar, and one way in which they are different.

8) How do the detection outcomes for single photons compare with the results for classical particles and for electromagnetic waves?

9) How does the behaviour of a single photon at the **second** beamsplitter compare with classical particles and with electromagnetic waves?

10) **Consider the case with two beamsplitters and the phase shift inserted into the lower path.**

Vary the phase shifter, and compare the detection outcomes for single photons and electromagnetic waves. List one way in which these outcomes are similar, and one way in which they are different.

11) Summarize your findings from all the questions by characterizing how photons behave in these experiments: In what sense do they behave like classical particles? In what sense do they behave like classical waves? Was there a case where the photons acted just like classical particles; or acted just like electromagnetic waves? Or must photons be something different to both electromagnetic waves and classical particles?