

For these questions, use the simulation “Quantum bomb detection” in the QuVis HTML5 collection.

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

2) Consider the setup shown in the simulation without any bomb present.

a) What are the probabilities for detecting the photon in detectors 1 and 2 for this setup?

b) After encountering the first beam splitter, is the single photon taking both paths simultaneously, or is it actually taking only one path or the other (but we can't know which one)? Justify your answer by considering the detection probabilities from part a).

3) Now consider the setup shown in the simulation with a bomb present. You do not know whether or not the bomb is defective. Ignore any phase shifts introduced through the bomb.

a) What are the probabilities for setting off the bomb and detecting the photon in detectors 1 and 2 if the bomb is defective? Explain your answer.

b) What are the probabilities for setting off the bomb and detecting the photon in detectors 1 and 2 if the bomb is in working order? Explain your answer.

4) Consider the setup shown in the simulation with a bomb present.

a) For a given bomb, you send three photons through the experiment, all of which are detected by detector 1. Can you say with certainty whether the bomb is defective or in working order?

b) For a given bomb, you send 10 photons through the experiment, nine of which are detected by detector 1 and one of which is detected by detector 2. Can you say with certainty whether the bomb is defective or in working order?

5) a) Imagine you inserted the bombs into the upper path between the two beamsplitters instead of the lower path. Would you be able to successfully determine whether some bombs are in working order without setting them off? If so, explain how. If not, explain why not.

b) Imagine you inserted the bombs into the path between the second beam splitter and detector 1 instead of the lower path. Would you be able to successfully determine whether some bombs are in working order without setting them off? If so, explain how. If not, explain why not.

6) Which of the Challenges did you find most difficult and why? Explain how you solved this challenge. If none of the Challenges were difficult, choose the one you found most interesting and explain how you solved it.