

**For these problems, use the simulation “Quantum key distribution with entangled spin  $\frac{1}{2}$  particles”**

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

2) Explain why the set of measurement outcomes produced by Alice in the simulation forms a perfectly random sequence of zeros and ones. Does the orientation of her SGA need to be random in order for her sequence of zeros and ones to be random?

3) (a) When generating a secure key, Alice and Bob throw away  $\sim 50\%$  of their measurements. Why do they throw out half of their measurement outcomes, while keeping the other half?

(b) Why would the key not be secure if Alice and Bob decided to use just a single fixed basis to derive the key? Describe how you can see this result in the simulation, including a description of the experimental setup and the measurements you are taking.

4) Configure the simulation so that both Alice and Bob are each using a randomly chosen basis for every particle pair.

(a) On average, what fraction of Bob's key will be incorrect when Eve intercepts and resends particles? Explain how these errors come about. Describe how you can see these results in the simulation, including a description of the experimental setup and the measurements you are taking.

(b) What actions could Alice and Bob take to determine whether or not Eve has compromised the security of their key?