Questions to Chapter 1 of book Quantum Computation and Quantum Information by Michael Nielsen and Isaac Chuang

Short answers. Do not provide details.

1. What is quantum electrodynamics?
2. What would happen if cloning were possible. Give one example.
3. What is Universal Turing Machine? Give an example of Turing machine.
4. Formulate Church-Turing Thesis
5. What is Moore's Law and how it is related to quantum computing?
6. What are efficient and inefficient algorithms – link to P=NP problem. Give examples.
7. Formulate the strengthened versions of Church-Turing thesis
8. What kinds of results were shown by Robert Solovay and Volker Strassen in 1970s? Why are they important?
9. What was the question that David Deutsch asked himself in 1985 related to Church-Turing Thesis?
10. What was the question that Richard Feynman asked related to simulating quantum mechanical systems?
11. What are the most famous quantum algorithms? Why are they important?
12. What are error-correcting codes? Give one example.
13. What was the achievement of Calderbank, Shorr and Steane in 1996? Explain importance
14. What is superdense coding?
15. What is networked information theory?
16. What is cryptography?
17. Compare definitions of private key cryptosystems and public key cryptosystems.
18. What is RSA? Why is it important?
19. Why RSA is in danger?
20. What is quantum entanglement?
21. What is a qubit?
22. Give three realizations of qubit in physics
23. What is Bloch sphere? Show an example.
24. What is hidden information of quantum computing?
25. What is EPR pair?
26. Give examples of five one-qubit gates and their unitary matrices.
27. What is a unitary matrix?
28. Visualize one-qubit gates on Bloch sphere
29. Universal decomposition of one-qubit systems. Present the gates and their interpretation on Bloch sphere
30. Feynman or CNOT gate as an example of a controlled 2-qubit gate. Explain.
31. Show other examples of 2-qubit quantum gates.
32. Give at least one set of 2-qubit and 1-qubit gates that is universal.
33. What is a link between quantum and reversible logic?
34. How to realize a swap gate using quantum primitives?
35. (difficult) Invent ternary gates that generalize the binary quantum gates from chapter 1. Design a ternary Toffoli gate, ternary Feynman gate etc. Build a

ternary swap gate using these primitives. First define the unitary matrix for each ternary quantum gate, including swap.

36. The role of measurement in quantum computing.
37. What is no-cloning theorem. Explain intuitively (no proof) why cloning is not possible, use Figure 1.11.
38. What are Bell states and how to generate them?
39. Realization of binary Toffoli gate.
40. Quantum parallelism.
41. Hadamard transform for 2 qubits
42. Be able to explain the Deutsch Algorithm for one qubit. Why is it very important although it is practically useless?
43. What is the essence of Deutsch – Jozsa results?
44. Describe briefly quantum algorithms based on Fourier Transform
45. Grover's quantum search problem, what is speedup, why it is important?
46. What is quantum simulation and why is it important?
47. Mutual relations of quantum simulation and Moore's Law.
48. Give definitions of the following complexity classes: P, NP, PSPACE, BPP, BQP. Give examples of algorithms in each.
49. What was proved by Stern-Gerlach and cascaded Stern-Gerlach experiments?
50. What are the prospects for practical quantum information processing?