Prelim 1 Review - Conceptual Questions

Alex Alemi

March 3, 2010

Below is a list of short questions I can up with as I paged through both Purcell and Griffiths. They are meant to be thought provoking and help you come to a greater appreciation and understanding of what we've discussed so far. You should try and get to the point where you are comfortable answering all of these questions (and more, the list is my no means complete).

1. What is charge?
2. What are its units?
3. Is charge conserved?
4. What is the difference between point charges and charge distributions?
5. Do we need both? Is one more *correct*?
6. How do charges interact?
7. What is Coulomb's law?
8. Does it share similarity to any other laws?
9. Are these similarilities coincidental?
10. Whats the difference between Electrostatics and Newtonian Gravitational statics?
11. What's a vector?
12. What does Superposition mean?
13. Is it an approximation, or true exactly?
14. Can you think of a situation in which it might not hold?
15. Can you imagine a hypothetical universe in which it might not hold?
16. What is the energy of a distribution of charges?
17. Does it depend on path?
18. What about Coulomb's law ensures that energy is path-independent?
19. What is the Electric Field?
20. What is it's units?
21. How is it defined?
22. How can you measure it?
23. What does it represent?
24. What does it mean?
25. Why is it useful?
26. Is it a global or local property?
27. What are field diagrams?
28. How do they work?
29. Can you draw them effectively?
30. If given a field diagram, what information can you extract?
31. What is a charge distribution?
32. Why do we introduce them?
33. How are they different from point charges?
34. What are the units?

35. What is Electric Flux?
36. Do you have a geometric picture of it?
37. What are it's units?
38. Why is it of interest?
39. What is Gauss' Law?
40. What does it say?
41. Why is it true?
42. What does it tell you?
43. When is it useful?
44. Do you understand both the integral form and the differential form?
45. How are they different?
46. When is each useful?
47. How can one use the differential form while still using point charges?
48. What's a divergence?
49. How would you measure it?
50. What does it tell you?
51. Do you have a geometric picture?
52. What is Gauss' Theorem (i.e. math theorem, not Gauss' law)
53. Can you reason its result geometrically?
54. What is the electric field outside a spherically symmetric charge distribution?
55. What is the field of a line charge?
56. What is the charge near an infinite sheet?
57. What is the force on a layer of charge?
58. Why is it the average of the fields inside and out?
59. When does bootstraping cause pause?
60. Can you express the energy of a charge distribution in terms of the electric field?
61. Does this energy differ at all from the previous energy formulas we were presented?
62. Does it work with point charges?
63. Does this cause concern?
64. Look at Question 1.29 in the text, and think about it in light of the previous few questions.
65. What is the line integral of the electric field?
66. How would you measure it?
67. What properties does it have?
68. What is electric potential?
69. What units does it have?
70. How is it related to Electric Field?
71. How is it related to Energy?
72. Do you understand the difference between potential (i.e. electric potential) and potential energy?
73. Is potential a scalar or vector?
74. If potential is an integral between two points, how can I construct a function of only one variable from it?
75. Does this cause any subtleties? How are these resolved?
76. What is a gradient?
77. How would you measure it?
78. Do you have a geometric picture of how it works?
79. How is it useful?
80. As an operator, from what spaces does it interact, i.e. what sort of quantity do you feed it and what sort of quantity do you get out?
81. Given a potential, can you find the electric field?

82. Given an electric field can you find a potential?
83. Given a charge distribution can you find the electric field 'from scratch'?
84. Given a charge distribution can you find the potential 'from scratch'?
85. Are these equally difficult?
86. What are equipotentials?
87. What properties do they have?
88. Given a diagram of field lines, can you construct the equipotentials?
89. Given a diagram of equipotentials, can you construct the electric field?
90. Can you compute a divergence in all coordinate systems?
91. Are some systems easier than others?
92. Can you transform between coordinate systems?
93. What is a Laplacian?
94. How would you measure it in the real world?
95. What sort of operator is it, i.e. it takes what and passes what?
96. Is it related to previous vector operators?
97. How is it useful in physics?
98. Can you compute it in different coordinate systems?
99. What is Laplace's Equation?
100. What is Poisson's Equation?
101. Can you solve these differential equations?
102. Under what conditions?
103. Can you think of a procedure by which to do it numerically?
104. Differential equations have boundary conditions. What sort of boundary conditions are usually given for a Poisson's equation?
105. Read Section 2.12 of Purcell and think about it.
106. Look at Figures 2.20 and 2.20' and think about them.
107. Are you sure you understand the figures yet?
108. How about now?
109. What is the curl?
110. How would you measure it in the real world?
111. What sort of operator is it?
112. How is it useful in physics?
113. Can you compute it in different coordinate systems?
114. What's Stokes Theorem?
115. Can you reason its result geometrically?
116. What's the curl of the Electric field?
117. Under what conditions would your answer change?
118. Why?
119. What is a conductor?
120. Why do they exist?
121. What would it mean for an object to the a conductor of gravity?
122. Do such items exist?
123. How do you summarize the results of conductors?
124. Is this an approximation?
125. Is it a good approximation?
126. How do Electric fields behave inside conductors?
127. Why?

128. How do Electric fields behave near the surface of a conductor?
129. Why?
130. What is the uniqueness theorem?
131. Why is a true (Physicist's proof)?
132. Why is it useful?
133. What happens when I put charge on a conductor?
134. What do people mean when they say 'screening'?
135. What is the method of images?
136. Why does it work?
137. When is it useful?
138. Does it play well with superposition?
139. So it appears to work for fields, does it work for forces? Work? Potential? Why or why not? x3
140. What is capacitance?
141. Does the name 'capacitance' make sense for what it is? Did Physics choose a proper word from english?
142. How is it defined?
143. What are its units?
144. Does that mean anything?
145. How would you calculate the capacitance of a couple conductors? (Think about how you would tackle the general problem)
146. How would you calculate the capacitance of a single conductor?
147. What is the capacitance of a parallel plate capacitor?
148. Why does it have the form it does? Think about scaling and dependences? Does it make sense? (i.e. if I increase X, what happens to C)
149. What is the capacitance of a sphere?
150. How does it scale, does it make sense, does it make sense in different limits?
151. What is the capacitance of a coax cable?
152. How does it scale, how does it behave in the limits?
153. Does this make sense?
154. How would you measure the capacitance of an object in the real world?
155. What are the boundary conditions on the electric field?
156. Why?
157. No seriously, why?
158. Did you make sure to discuss both the parallel and perpendicual components?
159. Can you think of a few different ways to justify them, or turning the question around, can you revist some old results and justify them using these boundary conditions?
160. What are the boundary conditions on the potential near charge surfaces?
161. Do these make sense?
162. How would you calculate the charges on a bunch of different conductors if given the potential?
163. How would you calculate the potentials of a bunch of different conductors if given the charges?
164. How much energy is stored in a capacitor?
165. Why?
166. Can you get it another way?
167. How is force related to energy?
168. How do charges behave inside of conductors?

169. How do charges behave inside of holes inside of conductors?

170. What is the dirac delta function?

171. What is its integral?

172. How it is used in physics?

173. Why is it used in physics?

174. What is induced charge?

175. How would you calculate it?

176. What is the field / potential of a point charge?

177. Of a Dipole? (a plus and minus charge separated by some distance)

178. of a Quadrople? (plus and minus charges at opposite corners of a square)

179. How do each of these scale as r. Why?

180. What would the force between dipoles be?

181. What would the force between quadropoles be?