

Prelim 2 Review - Conceptual Questions

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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).

Chapter 4 Purcell

1. What is electric current?
2. What are its units (CGS and/or SI)?
3. Why?
4. Is it a vector or a scalar?
5. How it is caused?
6. Would positive or negative charges moving the to right cause a positive current going to the right?
7. What is a current density?
8. What are its units (CGS and/or SI)?
9. Why?
10. Is it a scalar or a vector?
11. How are current and current density related?
12. Are you sure you're thinking vector calculusly?
13. Can you invert this relationship?
14. What is a simple model for electric current?
15. What causes the electrons to move?
16. What is a steady current?
17. What is true of the current density geometrically for steady currents?
18. Why?
19. How would this be modified if our currents weren't steady?
20. What is charge conservation?
21. What is an equation describing it?
22. Do you understand why it has the form it does?
23. Would all conservation laws have this form?
24. What is a conductor?
25. What is an insulator?
26. Is the distinction between these two absolute or one of scale?
27. Answer again in terms of scale, large or small compared to what?
28. What is Ohm's law?
29. What is the local differential form of Ohm's law?
30. What is it saying in English?
31. Is it surprising?
32. How might it be modified? (Next order terms, nonisotropy, etc)
33. Is it fundamental or empirical?

34. For what sort of materials does it hold?
35. When does it fail?
36. What is the integrated form of Ohm's law?
37. What is conductivity?
38. What are its units (CGS and/or SI)?
39. Why?
40. Can you get one from the other?
41. For what sort of systems would you use the integrated rather than differential form?
42. What is resistance?
43. What are its units (CGS and/or SI)?
44. Why?
45. What does it represent?
46. What is conductivity?
47. What sort of assumptions/approximations are we making when we use Ohm's law? Think about it first then read pgs 130,131.
48. How good are these assumptions/approximations?
49. What is resistivity?
50. What are its units (CGS and/or SI)?
51. Why?
52. How is it related to conductivity / resistance?
53. What are typical resistivities / conductivities of materials? (What order of magnitude)?
54. Think a little bit more about how electrical conduction actually works.
55. Section 4.4 of Purcell gives an excellent model for electrical conduction (otherwise known as the Drude model)
56. What is a metal?
57. Does it conduct or insulate?
58. How does it's conduction depend on temperature?
59. What is a semiconductor?
60. Does it conduct or insulate?
61. How do typical semiconductor conduction depend on temperature?
62. Note these last few questions are a favorite of the Physics GRE
63. What is a circuit?
64. What is a circuit element?
65. How many different circuit elements do you know?
66. How do you characterize their behavior?
67. What is the resistance of two resistors in series?
68. ... in parallel?
69. Why?
70. What about n resistors?
71. How do you solve a circuit in general?
72. What laws do you use?
73. Do these laws make sense?
74. What other ingredients must you know?
75. What nature of the solution of a circuit take?
76. Does a law of superposition hold for circuits?
77. Why or why not?
78. How is energy dissipated in circuits?
79. Why?
80. No really, why?
81. What is an electromotive force?
82. Why is it important?

83. Can you think of a few examples that provide it?
84. What is a typical range of voltages from chemical sources?
85. What's the voltage of a car battery?
86. How do you solve circuits with voltage sources?
87. What is a capacitor?
88. No, in the most general sense, what is a capacitor?
89. Why do we use the english term *capacitor*?
90. What do capacitors do?
91. How would I build one?
92. What is capacitance?
93. What are its units (CGS and/or SI)?
94. Why?
95. How do capacitors behave in circuits? (is it any different than normally?)
96. Can you solve a circuit involving a capacitor?
97. In a series CR circuit, how does the voltage change with time?
98. When I charge it?
99. When I discharge it?
100. What does the current through the resistor look like?
101. The charge on the capacitor?
102. The voltage across the resistor?
103. The voltage across the capacitor?
104. Do all of these make sense?
105. Do they all have the same general form?
106. Do you understand the form they have?
107. What happens for all of the above questions at $t = 0$? $t = \infty$?
108. Do the voltage curves have discontinuities? Why or why not?
109. Do the current curves have discontinuities? Why or why not?
110. Does the charge curve have a discontinuity? Why or why not?
111. Can you get these curves from the differential equation?
112. What is the characteristic time of the circuit?
113. Why?
114. What units does it have?
115. How would I get this time from a graph?
116. How would I graph a circuit given the characteristic time?
117. How does this time vary with the resistance?
118. How does it vary with the capacitance?
119. Do these two answers make sense?

Chapter 5 Purcell - Limited

1. What is the magnetic force?
2. What is the combined electric force?
3. How does it vary with charge?
4. With velocity?
5. In which direction does it point relative to the fields? To the velocity?
6. What is the charge of a moving charge?
7. Why?
8. What does charge invariance mean?
9. How is it different than charge conservation?

10. How does the electric field transform?
11. Can you think of a simple thought experiment to verify this?
12. What is β ?
13. What is γ ?
14. Over what range do the two cover?
15. What does the field of a moving point charge look like?
16. What if its moving fast?
17. What if its moving slow?
18. What does the field of a charge that starts or stops look like?
19. Why?
20. What about one that wiggles back and forth?
21. Is there any transverse component?
22. What r dependence does this have?
23. Why?
24. What is light?
25. Radio?
26. TV?
27. Microwaves?
28. Gamma rays?
29. Radar?
30. Lasers?
31. UV?
32. Get the picture?
33. What happens if you have a point charge near a wire carrying current?
34. What is magnetism?
35. Why does it exist?
36. If that's true, why do we still treat it as a separate thing?

Chapter 6 Purcell

1. What is magnetism?
2. What is the magnetic field?
3. What are its units (CGS and/or SI)?
4. Why?
5. Does it obey superposition?
6. Why do I care about it?
7. What is the magnetic force law?
8. What is the field surrounding a wire carrying a constant current?
9. Why?
10. Can you derive it a couple different ways?
11. What is the permeability of free space?
12. What is the permittivity of free space?
13. What are its units (CGS and/or SI)?
14. Why?
15. Do two wires carrying current in the same direction that are parallel feel a force?
16. Attractive or repulsive?
17. Why?
18. Do two wires carrying current in opposite directions that are parallel feel a force?
19. Attractive or repulsive?
20. Why?
21. What is the magnitude of the force in these two cases?
22. Why?
23. What about if the wires were perpendicular?
24. What does the magnetic field around a wire look like?

25. Why?
26. What is the curl of the magnetic field?
27. Do you have a geometric picture of what this means?
28. Is it true for points or regions?
29. Why?
30. Can you write this in integral form?
31. What is Ampere's law?
32. When is it true?
33. When is it useful?
34. Can it be used to calculate magnetic fields?
35. When?
36. What's the field around a wire?
37. What's the field near a sheet of charge?
38. What's the field of a toroid?
39. What's the field of an infinite solenoid?
40. What is the field inside of a thick wire?
41. Outside?
42. What if the current density is arbitrary?
43. Why why why why why?
44. How does symmetry enter into it?
45. How does spatial dependence enter into it?
46. How do the allowed directions enter into it?
47. What is the divergence of the magnetic field?
48. Do you have a geometric picture of what this means?
49. Why is it what it is?
50. Can you write this in integral form?
51. Are these true at points or regions?
52. Are there electrical counterparts to these two laws?
53. What are they?
54. How are they similar?
55. How are they different?
56. Why are they different?
57. Why are they similar?
58. What is the Biot-Savart law?
59. How does it scale in each of its parameters?
60. How do the directions all points?
61. How does it scale in r ?
62. Does this make sense?
63. What does it tell you?
64. How could you use it?
65. What is the field on axis of a wire loop?
66. Could you compute the field off axis?
67. In principle?
68. Why is the Biot-Savart law true?
69. Can you connect it to the other laws?
70. Could you write an electric field analogy?
71. What is the field of a finite solenoid?
72. Does this make sense?
73. What are the boundary conditions on the magnetic field?
74. I.e. What happens to the perpendicular component of the magnetic field when it crosses a current sheet?
75. What about the parallel component?
76. Do these make sense?
77. Really?

78. What is the magnetic field between two current sheets?
79. If the currents go in the same direction?
80. Opposite?
81. What about if they run perpendicularly?
82. Does the magnetic field store energy?
83. How much?
84. Can you draw an analogy to the electric field?
85. Can I build a magnetic analog of a capacitor?
86. What would it be storing energy as?
87. Can you think of the corresponding circuit element equation for this object?
88. Think about two magnets attracting each other?
89. First, can the magnetic field do work on a moving point charge?
90. Why or why not?
91. In light of that, we know that I can pick up a magnet on my desk with another magnet, how does this make sense?
92. Think again about whether the magnetic field stores energy or not?
93. Does it make sense now?
6. What is its curl?
7. What is its divergence?
8. How does the magnetic field transform?
9. The electric field?
10. What is the Hall effect?
11. How does the experiment work?
12. What does it tell you?
13. What particle is responsible for conduction in metals?
14. How do we know?
15. How does a charged particle behave in a magnetic field?
16. What's the cyclotron frequency?
17. What if its moving faster than this?
18. What if its moving slower than this?
19. How does a charged particle behave in crossed E and B fields?
20. Does this depend on the charge?
21. Does this depend on the mass?

Extra

EXTRA STUFF PROBABLY NOT ON THE TEST
BUT IN CHAPTER 6

1. What is the vector potential?
2. What are its units (CGS and/or SI)?
3. Why?
4. Why is it useful?
5. How do you compute it?