

**Study Questions for Hunt (1991) *The Maxwellians*.**

**Chapter 5**

1. What was the guiding principle in the revision of Maxwell's theory in the 1880s?
2. What sort of evidence was there that suggested energy could flow in seemingly empty space?
3. What were two formulations for the energy associated with a current? Where did each of these equivalent formulations locate this energy?
4. What were two formulations of the electrostatic energy?
5. How did Maxwell view the potential functions  $\mathbf{A}$  and  $\psi$ ? According to Hunt, why did this suggest the action-at-a-distance approach, as opposed to the field-theoretic approach?
6. According to Poynting, how does the energy flux  $\mathbf{S}$  relate to the electric and magnetic forces  $\mathbf{E}$  and  $\mathbf{H}$ ?
7. According to Poynting, what does the relation in #6 suggest about the nature of a current in a conductor?
8. According to FitzGerald, what was a problem with Maxwell's use of potential functions?
9. In the contemporary formulation of Maxwell's theory, what is the significance of the quantity  $\text{div } \mathbf{A}$ ?
10. Maxwell chose what is now called the "Coulomb gauge",  $\text{div } \mathbf{A} = 0$ . What type of problem in electromagnetism is this gauge useful for? What does it entail about the electric potential  $\psi$ ?
11. FitzGerald chose what is now called the "Lorentz gauge",  $\text{div } \mathbf{A} + d\psi/dt = 0$ . What type of problem in electromagnetism is this gauge useful for? What does it entail about the electric potential  $\psi$ ?
12. Why was the concept of energy important for Heaviside the telegrapher?
13. What was Thomson and Tait's "principle of activity"?
14. How did Heaviside use the principle of activity as a motivation to reformulate Maxwell's theory?
15. How did Heaviside view the potential functions  $\mathbf{A}$  and  $\psi$ ?
16. In what sense are the equations Heaviside deduced *symmetrical*?

**Chapter 6.**

1. What happened in 1876 (that was relevant to the development of telegraphy)?
2. Instead of pulses of current within a wire, how did Heaviside eventually treat electric signals?
3. Why did Thomson's treatment of electric signals as traveling *in* wires work?
4. What was Thomson's "KR Law"?
5. How did Heaviside suggest Thomson's law should be modified?
6. How did FitzGerald view signal propagation in telegraph wires?
7. What was Heaviside's concept of magnetic conductivity? Why had he introduced it into his reformulation of Maxwell's equations?
8. How does an electromagnetic wave become distorted when traveling through an electrically conductive medium? How can Heaviside's magnetic conductivity offset this distortion?
9. Heaviside's magnetic conductivity is hypothetical! So it can't be used in practice to offset EM wave distortion. What did Heaviside propose as the replacement mechanism to offset distortion?
10. According to Heaviside, what was the "life and soul" of long-distance telephony?
11. Why did Preece block Heaviside's 1887 journal article on self-inductance?
12. Who was "the Bouncer", "Mr. Priggs", and "Taffy"?
13. Why did Preece advocate copper wires? Why is copper a reliable conductor for electric signals?
14. How did Lodge conceive of self-inductance?
15. What was the "skin effect"? How did Lodge explain it?
16. Why did Lodge think self-inductance should be a primary consideration in the design of lightning conductors? What is the error with this view?
17. Despite the error, what significance did Lodge's view of self-induction have for the debate between Heaviside and Preece?

**Chapter 7.**

1. How was Hertz introduced to Maxwell's theory?
2. How did Maxwell's theory differ in its predictions from the theories of Weber and Neumann?
3. What was Hertz's key observation of 1886?
4. Describe some of the experiments Hertz conducted to demonstrate the existence and generation of electromagnetic waves in free space.
5. What did FitzGerald think Hertz's demonstrations implied about action-at-a-distance theories?
6. Was Thomson a Maxwellian? What aspect of Maxwell's theory did he criticize?
7. What was involved in the murders of  $\psi$  and  $\mathbf{A}$ ?
8. According to Hunt, what was the fundamental issue in the "practice versus theory" debate? Which side prevailed in the end?