7.1 Introduction

The electromagnetic force is central to nearly every physical process around us and is a major component of classical physics. In fact, the development of electromagnetic theory in the nineteenth century gave us much mathematical machinery that we now apply quite generally in other fields, including potential theory, vector calculus, and the ideas of divergence and curl.

It is therefore not surprising that this section deals with a large array of physical quantities and their relationships. As usual, SI units are assumed throughout. In the past electromagnetism has suffered from the use of a variety of systems of units, including the cgs system in both its electrostatic (esu) and electromagnetic (emu) forms. The fog has now all but cleared, but some specialised areas of research still cling to these historical measures. Readers are advised to consult the section on unit conversion if they come across such exotica in the literature.

Equations cast in the rationalised units of SI can be readily converted to the once common Gaussian (unrationalised) units by using the following symbol transformations:

Equation conversion: SI to Gaussian units

$\epsilon_0 \mapsto 1/(4\pi)$	$\mu_0 \mapsto 4\pi/c^2$	$\boldsymbol{B} \mapsto \boldsymbol{B}/c$
$\chi_E \mapsto 4\pi\chi_E$	$\chi_H \mapsto 4\pi\chi_H$	$\boldsymbol{H} \mapsto c\boldsymbol{H}/(4\pi)$
$\boldsymbol{A} \mapsto \boldsymbol{A}/c$	$\boldsymbol{M} \mapsto c\boldsymbol{M}$	$\boldsymbol{D} \mapsto \boldsymbol{D}/(4\pi)$

The quantities ρ, $\boldsymbol{J}$, $\boldsymbol{E}$, ϕ, σ, $\boldsymbol{P}$, ϵ_r, and μ_r are all unchanged.