Introduction to Electrodynamics, 4th ed.
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Corrections to the Instructor's Solution Manual
(These corrections have been made in the current electronic version.)
(August 1, 2014)

- Page 39, Problem 2.40(b): "a" → "an".
- Page 47, Problem 5.27(b): $Q/b \to Q/2b$.
- Page 51, Problem 2.60, replace with the following:

  Problem 2.60 The initial configuration consists of a point charge q at the center, $-q$ induced on the inner surface, and $+q$ on the outer surface. What is the energy of this configuration? Imagine assembling it piece-by-piece. First bring in q and place it at the origin—this takes no work. Now bring in $-q$ and spread it over the surface at a—using the method in Prob. 2.35, this takes work $-q^2/(8\pi\epsilon_0 a)$. Finally, bring in $+q$ and spread it over the surface at b—this costs $q^2/(8\pi\epsilon_0 b)$. Thus the energy of the initial configuration is

  $$W_i = -\frac{q^2}{8\pi\epsilon_0}\left(\frac{1}{a} - \frac{1}{b}\right).$$

  The final configuration is a neutral shell and a distant point charge—the energy is zero. Thus the work necessary to go from the initial to the final state is

  $$W = W_f - W_i = \boxed{\frac{q^2}{8\pi\epsilon_0}\left(\frac{1}{a} - \frac{1}{b}\right).}$$

- Page 57, Problem 3.11, line 7: $W = \frac{1}{4}\cdots \to W = \frac{1}{2}\cdots$; in the boxed equation on that same line, $32 \to 16$.
- Page 69, Problem 3.25, first boxed equation: remove first minus sign.
- Page 99, Problem 4.22, equation following "Condition (i) says": $s \to a$ (middle term).
- Page 154, Problem 7.37: reverse the sign of every q (a total of 10 times).
- Page 170, Problem 8.4(a), figure: remove plus and minus signs in front of the two q's; switch axis labels x and y.
- Page 171, Problem 8.5, replace with the following:

Problem 8.5

(a) $\mathbf{E} = -\frac{\sigma}{\epsilon_0}\,\hat{\mathbf{z}}, \quad \mathbf{B} = -\mu_0\sigma v\,\hat{\mathbf{x}}, \quad \mathbf{g} = \epsilon_0(\mathbf{E}\times\mathbf{B}) = \mu_0\sigma^2 v\,\hat{\mathbf{y}}, \quad \mathbf{p} = (dA)\mathbf{g} = \boxed{dA\mu_0\sigma^2 v\,\hat{\mathbf{y}}.}$

(b) (i) There is a *magnetic* force, due to the (average) magnetic field at the upper plate:

$$\mathbf{F} = q(\mathbf{u}\times\mathbf{B}) = \sigma A[(-u\,\hat{\mathbf{z}})\times(-\tfrac{1}{2}\mu_0\sigma v\,\hat{\mathbf{x}})] = \tfrac{1}{2}\mu_0\sigma^2 Avu\,\hat{\mathbf{y}},$$

$$\mathbf{I}_1 = \int \mathbf{F}\,dt = \tfrac{1}{2}\mu_0\sigma^2 Av\,\hat{\mathbf{y}}\int u\,dt = \tfrac{1}{2}d\mu_0\sigma^2 Av\,\hat{\mathbf{y}}.$$

[The velocity of the patch (of area A) is actually $\mathbf{v}+\mathbf{u} = v\,\hat{\mathbf{y}} - u\,\hat{\mathbf{z}}$, but the y component produces a magnetic force in the z direction (a repulsion of the plates) which reduces their (electrical) attraction but does not deliver (horizontal) momentum to the plates.]

(ii) Meanwhile, in the space immediately above the upper plate the magnetic field drops abruptly to zero (as the plate moves past), inducing an *electric* field by Faraday's law. The magnetic field in the vicinity of the top plate (at $d(t) = d_0 - ut$) can be written, using Problem 1.46(b),

$$\mathbf{B}(z,t) = -\mu_0\sigma v\,\theta(d-z)\,\hat{\mathbf{x}}, \quad \Rightarrow \quad \frac{\partial\mathbf{B}}{\partial t} = \mu_0\sigma vu\,\delta(d-z)\,\hat{\mathbf{x}}.$$

In the analogy at the beginning of Section 7.2.2, the Faraday-induced electric field is just like the magnetostatic field of a surface current $\mathbf{K} = -\sigma vu\,\hat{\mathbf{x}}$. Referring to Eq. 5.58, then,

$$\mathbf{E}_{\text{ind}} = \begin{cases} -\frac{1}{2}\mu_0\sigma vu\,\hat{\mathbf{y}}, & \text{for } z < d, \\ +\frac{1}{2}\mu_0\sigma vu\,\hat{\mathbf{y}}, & \text{for } z > d. \end{cases}$$

This induced electric field exerts a force on area A of the *bottom* plate, $\mathbf{F} = (-\sigma A)(-\frac{1}{2}\mu_0\sigma vu\,\hat{\mathbf{y}})$, and delivers an impulse

$$\mathbf{I}_2 = \tfrac{1}{2}\mu_0\sigma^2 Av\,\hat{\mathbf{y}}\int u\,dt = \tfrac{1}{2}\mu_0\sigma^2 Avd\,\hat{\mathbf{y}}.$$

(I dropped the subscript on d_0, reverting to the original notation: d is the initial separation of the plates.)

The total impulse is thus $\mathbf{I} = \mathbf{I}_1 + \mathbf{I}_2 = \boxed{dA\mu_0\sigma^2 v\,\hat{\mathbf{y}},}$ matching the momentum initially stored in the fields, from part (a). [I thank Michael Ligare for untangling this surprisingly subtle problem. Incidentally, there is also "hidden momentum" in the original configuration. It is not relevant here; it is (relativistic) mechanical momentum (see Example 12.13), and is delivered to the plates as they come together, so it does not affect the overall conservation of momentum.]

- Page 182, Problem 8.23, line 3: $\mathbf{H}(\boldsymbol{\nabla} \times \mathbf{E}) \to \mathbf{H} \cdot (\boldsymbol{\nabla} \times \mathbf{E})$.
- Page 222, Problem 10.25, downsloping arrow at upper right: in the equation for $\mathbf{B}$, remove the dot over the first $\mathbf{J}$.
- Page 227, end of line 3: $(2\sqrt{ac} + b) \to (2\sqrt{ac} + b)^{-1}$.
- Page 235, Problem 11.8: insert just before (b)

  > [Technically, $\dot{Q}(t)$ is discontinuous at $t = 0$, and $\ddot{Q}$ picks up a delta function. But any *real* circuit has some (self-)inductance, which smoothes out the sudden change in $\dot{Q}$.]

- Page 284, Problem 12.65(b), figure: remove the two v's (left and right sloping sides).