Corrections to

Introduction to Classical Mechanics
With Problems and Solutions

All printings up to 2013

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The corrections below are listed by page number. They are grouped into three categories: (1) Important errors that will cause confusion, (2) minor errors that might cause confusion, and (3) trivial errors that should not cause confusion. Additional clarifications are listed at the end.

Important errors:

88: Solution to Problem 3.7: The first sentence of the second paragraph states, "Because the magnitudes of the friction force and the gravitational force along the plane are equal, the acceleration along the direction of motion equals the negative of the acceleration in the direction down the plane." Although this statement is correct, more explanation is required. This issue is that these two directions aren't orthogonal, so the accelerations in the two directions aren't independent.

The correct justification is given in the figure below. At a given time t, let the velocity be $\mathbf{v}_{\text{old}}$, as shown. A small time Δt later, the velocity is $\mathbf{v}_{\text{new}}$. The gravitational and frictional forces (both with magnitude $mg \sin\theta$) are indicated, along with the net force obtained by completing the parallelogram (which is a rhombus in this case) formed by the two individual forces and the dotted lines shown. Since we are drawing things alongside the velocity vectors, we have actually drawn the changes in *velocity* acquired during the small time Δt. That is, the total acceleration is $\mathbf{a}_{\text{net}} = \mathbf{F}_{\text{net}}/m$, so the total change in the velocity vector is $\mathbf{a}_{\text{net}} \, \Delta t = \mathbf{F}_{\text{net}} \, \Delta t/m$, as shown.
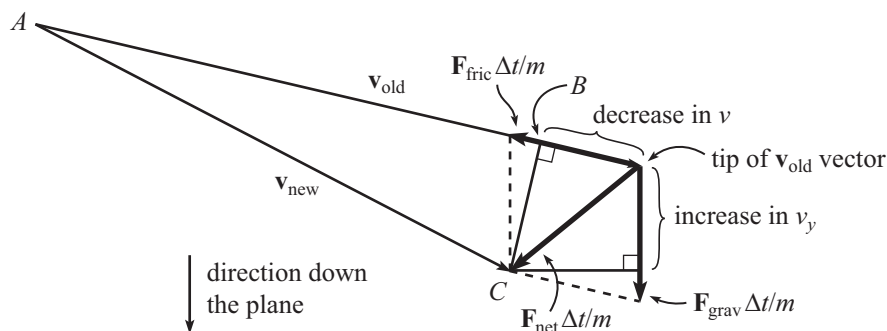
In going from $\mathbf{v}_{\text{old}}$ to $\mathbf{v}_{\text{new}}$, the increase in v_y is indicated in the figure (positive v_y points down the plane). Additionally, since Δt is assumed to be small, $\mathbf{v}_{\text{new}}$ is essentially parallel to $\mathbf{v}_{\text{old}}$. So the length AB in the figure is essentially equal to the length AC. The length of $\mathbf{v}$ (that is, $v \equiv \sqrt{v_x^2 + v_y^2}$) therefore decreases by the amount indicated. But since the parallelogram formed by the individual forces is in fact a rhombus, the decrease in v equals the increase in v_y. The sum $v + v_y$ is therefore constant throughout the motion, as claimed. The rest of the solution proceeds as stated.

183: Exercise 5.48: Modify part (b) of this problem to read: "(b) the ball is not allowed to touch the pipe, but assume that it skims the top of the pipe." Without this extra

condition, the problem is more difficult, and it turns out (as you are encouraged to show) that the minimum-speed trajectory actually skims the pipe at points 45° down from the top, as opposed to skimming it at the top.

427: Exercise 9.55: The level of this exercise should be increased to four stars, and the latter part should now read:

> ...of radius $R/2$. Assume that the coefficient of friction between the ball and the cone is arbitrarily large. What is the frequency of precession, Ω? Show that the condition on ℓ for the setup to be possible is $\ell > (3\sqrt{3}/4)R$. If we instead have a solid ball with $I = (2/5)mR^2$, find Ω and show that the condition on ℓ is $(5\sqrt{3}/2)R > \ell > (5\sqrt{3}/8)R$. What about a general $I = \beta mR^2$? There is a special value of β; what is it, and why is it special?

484: Exercise 10.24 should be replaced with:

> At a polar angle θ, a projectile is fired eastward with speed v_0 at an angle α above the ground. Show that the southward (in the northern hemisphere) and eastward deflections due to the Coriolis force are (to first order in ω)
>
> $$\begin{aligned} d_{\text{south}} &= (4\omega v_0^3/g^2)\cos\theta\cos\alpha\sin^2\alpha, \\ d_{\text{east}} &= (4\omega v_0^3/g^2)\sin\theta\Big(\cos^2\alpha\sin\alpha - (1/3)\sin^3\alpha\Big). \end{aligned}$$
>
> *Hint*: The first term in d_{east} arises because the flight time is modified due to the vertical component of the Coriolis force.

Minor errors:

116: The line before Eq. (4.46): The $e^{i\omega t}$ should be $e^{i\alpha t}$.

237: In Eq. (6.59) we're concerned with infinitesimal ϵ, so the derivative $dL/d\epsilon$ is being evaluated at $\epsilon = 0$. So it should read "$0 = \frac{dL}{d\epsilon}|_{\epsilon=0} = \ldots$" The other terms throughout the proof should technically also have the "$|_{\epsilon=0}$" restriction.

259: 6th line on page: "numerically using Eq. **(6.125)**"

287: 2nd sentence of Section 7.4.1: The order of $M_\odot$ and m should be reversed.

314: 2nd line of 2nd paragraph of the Remarks: The square root should be removed. So it should read, "$a = g\sin\theta/(1 + \beta)$."

319: Eq. (8.27): After the second "=" sign the exponent should be 4, not 2. So it should read, "$(R^4/4)\rho\pi$."

349: 3rd line of solution to Problem 8.1: The second "2" should not be there. So it should read, "$-2mgd + mgd = -mgd$."

364: Eq. (8.124): There is an extra factor of V_0 in the expression for ω; the V_0 in front of the fraction should be removed.

547: Eq. (11.72): The upper-right entry in the matrix on the righthand side should be $v_1 + v_2$.

588: 2nd line of Remark 3: We haven't dropped the c's at this point, so it should read, "$E = \gamma mc^2$"

590: Last line on page: Again, we haven't dropped the c's yet, so it should read, "$E^2 - |\mathbf{p}|^2 c^2 = m^2 c^4$."

Trivial errors:

259: 8th line on page: "in **the** first case"

320: Eq. (8.30): There should be a $d\theta$ in the last integral in the first line.

343: Fig. 8.51: The m's should be capital M's.

368: Fig. 8.80: The V should be a V_0.

Clarifications:

72: Problem 3.13: In this pencil-balancing problem, we're assuming that the rod is infinitely thin, or equivalently that the tip is infinitely sharp. This is therefore a hypothetic problem. If you want to get realistic and assume that the tip is at least as wide as an atom, then things get very tricky: Is the bottom atom flat, in which case the pencil has to extract itself from a potential well? Or is the atom round, in which case there is no potential well? And what are the forces between the atom and the one(s) it touches on the table? Tricky indeed.

336: 4th line of Problem 8.14: Clarification: "free to rotate about its **fixed** axis"