Errata for
The Feynman Lectures on Physics Volume I
Definitive Edition (Caltech Approved)

The errors in this list appear in *The Feynman Lectures on Physics: Definitive Edition* and earlier editions; all corrections have been approved by Caltech; these errors will be corrected in future editions.

Errors are listed in the order of their appearance in the book. Each listing consists of the errant text followed by a brief description of the error, followed by corrected text.

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I:xiii, par 4

The supernova of 1987 has just been discovered, and Feynman was very excited about it.

Incorrect word ('has' instead of 'had').

The supernova of 1987 had just been discovered, and Feynman was very excited about it.

I:10, Table of Contents, Chapter 24

24-2 Damped oscillations 24-2

Wrong page number.

24-2 Damped oscillations 24-3

I:I-2, par 3

The first is more exciting, more wonderful, and more fun, but the second is easier to get at first, and is a first step to a real understanding of the second idea.

Opposite sense of what was originally said (refer to tape) –very confusing wording.

The first is more exciting, more wonderful, and more fun, but the second is easier to get at first, and is a first step to a real understanding of the more correct but unfamiliar idea.

I:I-3, par 2

… so we say they are 1 or 2 angstroms (A) in radius.

Incorrect abbreviation for angstrom (Å).

… so we say they are 1 or 2 angstroms (Å) in radius.

I:I-3, par 4

… the distance between the center of a hydrogen and the center of the oxygen is 0.957 A.

Incorrect abbreviation for angstrom (Å).

… the distance between the center of a hydrogen and the center of the oxygen is 0.957 Å.

I:2-9, par 4

There is a "lambda," with a mass of 1154 Mev, ...

Wrong mass (see Table 2-2).

There is a "lambda," with a mass of 1115 Mev, ...

I:2-9, Table 2-2, bottom line

$$\frac{\varepsilon^-}{0.51}$$

Wrong symbol for electron ('ε' vs. 'e').

$$\frac{e^-}{0.51}$$

I:6-6, par 1

The expected value of D_N is then $D_{N-1}^2 + 1$.

Missing exponent ('D_N' vs. 'D_N^2').

The expected value of D_N^2 is then $D_{N-1}^2 + 1$.

I:6-6, Eq 6.9

$$D_N^2 = N \tag{6.9}$$

Missing (expectation) brackets ('D_N^2' vs. '$\left\langle D_N^2 \right\rangle$').

$$\left\langle D_N^2 \right\rangle = N \tag{6.9}$$

I:11-2, par 3

… so we find that

$$dx'/dt = dx/dt'$$

Typographical error (there should be no prime on the t).

… so we find that

$$dx'/dt = dx/dt$$

I:13-1, par 4

Thus the rate of change of the kinetic energy is $-mg\left(dh/dt\right)$, which quantity, miracle of miracles, is the rate of change of something else! It is the time rate of change of mgh !

Wrong signs ('minus' inserted in two places).

Thus the rate of change of the kinetic energy is $-mg\left(dh/dt\right)$, which quantity, miracle of miracles, is minus the rate of change of something else! It is minus the time rate of change of mgh !

I:13-2, par 1

… and the tangential force F_t is not mg but is weaker by the ratio …

Wrong sign.

… and the tangential force F_t is not $-mg$ but is weaker by the ratio …

I:13-2, par 1

… but is weaker by the ratio of the distance *ds* along the path to the vertical distance *dh.*

Ratio is inverted (see following unnumbered Eq).

… but is weaker by the ratio of the vertical distance *dh* to the distance *ds* along the path.

I:13-2, par 1

Thus we get $-mg\left(dh/dt\right)$, which is equal to the rate of change of mgh as before.

Wrong sign.

Thus we get $-mg\left(dh/dt\right)$, which is equal to the rate of change of $-mgh$ as before.

I:13-4, par 1

As we know, the force is GM/r^2 times the mass *m*,

Wrong sign.

As we know, the force is $-GM/r^2$ times the mass *m*,

I:13-4, par 4

$$W_{12} = \int_1^2 \mathbf{F} \cdot d\mathbf{s} = \int_1^2 -GMm \frac{dr}{r^2} = -GMm\left(\frac{1}{r_2} - \frac{1}{r_1}\right)$$

Wrong sign on right-hand side.

$$W_{12} = \int_1^2 \mathbf{F} \cdot d\mathbf{s} = \int_1^2 -GMm \frac{dr}{r^2} = GMm\left(\frac{1}{r_2} - \frac{1}{r_1}\right)$$

I:13-5, par 1

$$W_{34} = \int_3^4 \mathbf{F} \cdot d\mathbf{s} = -GMm\left(\frac{1}{r_4} - \frac{1}{r_3}\right)$$

Wrong sign on right-hand side.

$$W_{34} = \int_3^4 \mathbf{F} \cdot d\mathbf{s} = GMm\left(\frac{1}{r_4} - \frac{1}{r_3}\right)$$

I:13-5, par 1

In the same fashion, we find that $W_{45} = 0$, $W_{56} = -GMm\left(1/r_6 - 1/r_5\right)$, $W_{67} = 0$, $W_{78} = -GMm\left(1/r_8 - 1/r_7\right)$, and $W_{81} = 0$

Wrong signs on right-hand sides (2 of them).

In the same fashion, we find that $W_{45} = 0$, $W_{56} = GMm\left(1/r_6 - 1/r_5\right)$, $W_{67} = 0$, $W_{78} = GMm\left(1/r_8 - 1/r_7\right)$, and $W_{81} = 0$

I:13-5, par 1

$$W = GMm\left(\frac{1}{r_1} - \frac{1}{r_2} + \frac{1}{r_3} - \frac{1}{r_4} + \frac{1}{r_5} - \frac{1}{r_6} + \frac{1}{r_7} - \frac{1}{r_8}\right).$$

Wrong signs (8 of them).

$$W = GMm\left(\frac{1}{r_2} - \frac{1}{r_1} + \frac{1}{r_4} - \frac{1}{r_3} + \frac{1}{r_6} - \frac{1}{r_5} + \frac{1}{r_8} - \frac{1}{r_7}\right).$$

I:13-8, par 1

Answer: $d\mathbf{C} = G\left(dm\mathbf{r}/r^3\right)$.

Wrong sign. (See Fig. 13-5: the positive x-axis points away from the sheet, and the field vector $\mathbf{C}$ points toward the sheet.)

Answer: $d\mathbf{C} = -G\left(dm\mathbf{r}/r^3\right)$.

I:13-8, par 1, unnumbered Eq

$$dC_x \;=\; G\frac{dmr_x}{r^3} \;=\; G\frac{dma}{r^3}\,.$$

Wrong signs (two of them). (See error I:13-8, par 1)

$$dC_x \;=\; -G\frac{dmr_x}{r^3} \;=\; -G\frac{dma}{r^3}$$

I:13-8, par 1, unnumbered Eq

$$dC_x \;=\; G\mu 2\pi\rho\frac{d\rho a}{r^3}\,.$$

Wrong sign. (See error I:13-8, par 1)

$$dC_x \;=\; -G\mu 2\pi\rho\frac{d\rho a}{r^3}$$

I:13-8, Eq 13.17

$$C_x \;=\; 2\pi G\mu a\int_a^\infty \frac{dr}{r^2} = 2\pi G\mu a\left(\frac{1}{a}-\frac{1}{\infty}\right) = 2\pi G\mu\,. \tag{13.17}$$

Wrong signs (three of them). (See error I:13-8, par 1)

$$C_x \;=\; -2\pi G\mu a\int_a^\infty \frac{dr}{r^2} = -2\pi G\mu a\left(\frac{1}{a}-\frac{1}{\infty}\right) = -2\pi G\mu\,. \tag{13.17}$$

I:13-8, par 2

we merely note that G, gravity, plays the same role as $1/4\pi\varepsilon_0$ for electricity.

Wrong sign (compare Newton's gravitational force and Coulomb's electrical force, as given in section I:12-4). Also, missing word ('gravity' vs. 'for gravity').

we merely note that $-G$, for gravity, plays the same role as $1/4\pi\varepsilon_0$ for electricity.

I:13-8, par 3

Also, the force *between* the the two plates is clearly twice as great as that from one plate, namely $E = \sigma/\varepsilon_0$,

Wrong word ('force' vs 'field'): E is the electric field.

Also, the field *between* the the two plates is clearly twice as great as that from one plate, namely $E = \sigma/\varepsilon_0$,

I:13-9, par 2, 5th unnumbered Eq

$$\frac{dx}{r} = \frac{dr}{R}.$$

Wrong sign. (See preceding Eq.)

$$\frac{dx}{r} = -\frac{dr}{R}.$$

I:13-9, par 2, 6th unnumbered Eq

$$dW = -\frac{Gm' 2\pi a \mu}{R},$$

Wrong sign. (See error I:13-9, par 2, 5th unnumbered Eq.)

$$dW = \frac{Gm' 2\pi a \mu}{R}.$$

I:13-9, par 2, 7th unnumbered Eq

$$W = -\frac{Gm'2\pi a\mu}{R}\int_{R-a}^{R+a} dr\ ,$$

Wrong sign (See error I:13-9, par 2, 6th unnumbered Eq.) and wrong order of integration (assuming we are integrating from $x = -a$ to $x = a$, and taking x positive to the right in Fig 13-6, so that r ranges from $R + a$ to $R - a$.) (Note: two wrongs make the equation right in this case. Nonetheless the following changes are recommended for consistency with the corrections to the preceding (unnumbered) equations .

$$W = \frac{Gm'2\pi a\mu}{R}\int_{R+a}^{R-a} dr\ .$$

I:13-9, par 3

Making the same calculation, but with *P* on the inside, we still get the difference of the two *r*'s, but now in the form $a + R - (a - R) = 2R$, or twice the distance from the center;

Wrong order of integration (inside the sphere, where $R < a$, integrating from $x = -a$ to $x = a$, implies that r ranges from $a + R$ to $a - R$ (See error I:13-9, par 2, 7th unnumbered Eq.) , wrong sign (two of them: '$2R$' vs. '$-2R$' and 'twice the distance' vs. 'minus twice the distance').

Making the same calculation, but with *P* on the inside, we still get the difference of the two *r*'s, but now in the form $a - R - (a + R) = -2R$, or minus twice the distance from the center;

.

I:14-8, par 1

… and we wish to know the potential Ψ at some arbitrary point *p*. This is simply the sum of the potentials at *P* due to the individual masses taken one by one:

Incorrect capitalization ('*P*' vs. '*p*').

… and we wish to know the potential Ψ at some arbitrary point *p*. This is simply the sum of the potentials at *p* due to the individual masses taken one by one:

I:14-9, par 3

The mathematicians have invented a glorious new symbol, ∇, called "grad" …

The gradient symbol should be bold ('∇' vs. '$\boldsymbol{\nabla}$').

The mathematicians have invented a glorious new symbol, $\boldsymbol{\nabla}$, called "grad" ...

I:14-9, par 3

... called "grad" or "gradient" which is not a quantity but an *operator* which makes a vector from a scalar.

Two errors: there should be a comma before "which," and the second "which" should be "that."

... called "grad" or "gradient," which is not a quantity but an *operator* that makes a vector from a scalar.

I:14-9, Eq 14.14

$$\mathbf{F} = -\nabla U, \quad \mathbf{C} = -\nabla \Psi. \tag{14.14}$$

The gradient symbol should be bold ('∇' vs. '$\boldsymbol{\nabla}$'), two occurences.

$$\mathbf{F} = -\boldsymbol{\nabla} U, \quad \mathbf{C} = -\boldsymbol{\nabla} \Psi. \tag{14.14}$$

I:14-9, par 3

Using ∇ gives us a quick way of testing whether we havea real vector equation or not,

The gradient symbol should be bold ('∇' vs. '$\boldsymbol{\nabla}$').

Using $\boldsymbol{\nabla}$ gives us a quick way of testing whether we havea real vector equation or not,

I:14-9, par 3

… Eq. (14.14) means precisely the same as Eqs. (14.11) and (14.12);

Incomplete statement (and lack of plural 's' for Eqs 14.14).

… Eqs. (14.14) mean precisely the same as Eqs. (14.11), (14.12) and (14.13);

I:14-9, par 3

… and since we do not want to write three equations every time, we just write ∇U instead.

The gradient symbol should be bold ('∇' vs. '$\boldsymbol{\nabla}$').

… and since we do not want to write three equations every time, we just write $\boldsymbol{\nabla} U$ instead.

I:14-9, par 4

It is easy to show from Eq. (12.10) that the force on a particle due to magnetic fields is …

Incorrect reference.

It is easy to show from Eq. (12.11) that the force on a particle due to magnetic fields is …

I:14-9, par 4, unnumbered Eq

$$\phi(\mathbf{r}) = \int \mathbf{E} \cdot d\mathbf{s}\,,$$

Wrong sign (see preceding text).

$$\phi(\mathbf{r}) = -\int \mathbf{E} \cdot d\mathbf{s}\,,$$

I:21-6, par 1

So we put (21.10) into (21.9), and get …

Incorrect reference.

So we put (21.10) and (21.9) into (21.8), and get …

I:22-6, Table 22-2, 3rd line

$$\therefore 2 = (1.77828)(1.074607)(1.036633)(1.090350)(1.000573)$$

Wrong number (‘1.090350’ vs. ‘1.0090350’).

$$\therefore 2 = (1.77828)(1.074607)(1.036633)(1.0090350)(1.000573)$$

I:22-6, Table 22-2, 4th line

$$= 10\left[\frac{1}{1024}\left(256 + 32 + 16 + 4 + 0.254\right.\right] = 10\left[\frac{308.254}{1024}\right]$$

Missing parentheses after 0.254.

$$= 10\left[\frac{1}{1024}\left(256 + 32 + 16 + 4 + 0.254\right)\right] = 10\left[\frac{308.254}{1024}\right]$$

I:22-9, par 2

… it is best to multiply "512" by "128." This gives 0.13056 + 0.99144*i*.

Arithmetic error. (see Table 22-3).

… it is best to multiply "512" by "128." This gives 0.13056 + 0.99159*i*.

I:22-9, par 2

Thus we choose "64"… This then gives −0.01350 + 0.99993*i*.

Arithmetic error. (see Table 22-3).

Thus we choose "64"… This then gives −0.01308 + 1.00008*i*.

I:22-9, par 2

Therefore $\log_{10} i = 0.68226i$.

Arithmetic error.

Therefore $\log_{10} i = 0.68184i$.

I:22-9, Table 22-4, leftmost column heading

$p = \text{power} \cdot 8i$

Arithmetic error. ('$8i$' vs. '$8/i$').

$p = \text{power} \cdot 8/i$

I:22-10, par 1

We worked it out before., in the base 10 it was 0.68226*i*,

Arithmetic error. (See correction for I:22-9 par 2.)

We worked it out before., in the base 10 it was 0. 68184*i*,

I:22-10, par 1

… but when we change our logarithmic scale to e, we have to multiply by 2.3025, and if we do that it comes out 1.5709.

Arithmetic error. (See correction for I:22-10 par 1, above. Also note that the following statement, that "it differs from the regular $\pi/2$ by only one place in the last point" is true when "it" equals 1.570 because $\pi/2$ = 1.571, to 3 digits accuracy.)

… but when we change our logarithmic scale to e, we have to multiply by 2.3025, and if we do that it comes out 1.570.

I:23-6, par 2

the second derivative of $\hat{q}$ is $(i\omega)^2\hat{q}$; the first derivative is $(i\omega)q$.

Missing caret on (final) 'q'.

the second derivative of $\hat{q}$ is $(i\omega)^2\hat{q}$; the first derivative is $(i\omega)\hat{q}$.

I:23-6, unnumbered equation before Eq 23.18

$$q = \frac{\hat{V}}{L(i\omega)^2 + R(i\omega) + \frac{1}{C}}$$

Missing caret on 'q'.

$$\hat{q} = \frac{\hat{V}}{L(i\omega)^2 + R(i\omega) + \frac{1}{C}}$$

I:24-6, par 1, unnumbered Eqs

$$x = e^{-\gamma t/2}\left(Ae^{i\omega\gamma t} + A^*e^{-i\omega\gamma t}\right),$$
$$dx/dt = e^{-\gamma t/2}\left[\left(-\lambda/2 + i\omega_\gamma\right)Ae^{i\omega\gamma t} + \left(-\lambda/2 - i\omega_\gamma\right)A^*e^{-i\omega\gamma t}\right],$$

Typographical error ('$\omega\gamma$' vs. 'ω_γ' in the exponets of e - four occurences).

$$x = e^{-\gamma t/2}\left(Ae^{i\omega_\gamma t} + A^*e^{-i\omega_\gamma t}\right),$$
$$dx/dt = e^{-\gamma t/2}\left[\left(-\lambda/2 + i\omega_\gamma\right)Ae^{i\omega_\gamma t} + \left(-\lambda/2 - i\omega_\gamma\right)A^*e^{-i\omega_\gamma t}\right],$$

I:24-6, Eq 24.21

$$A_I = (v_0 + \gamma x_0/2)/2\omega_\gamma \tag{24.21}$$

Wrong sign.

$$A_I = -(v_0 + \gamma x_0/2)/2\omega_\gamma \tag{24.21}$$

I:26-3, par 5

… the light goes to the mirror in such a way that it comes back to the point B' in the *least possible time*.

There should be no 'prime' on B – the light reflected by the mirror goes to B.

… the light goes to the mirror in such a way that it comes back to the point B in the *least possible time*.

I:26-4, par 3

… noting that

$$EXC = ECN = \theta_i, \quad \text{and} \quad XCF = BCN' = \theta_r,$$

we have …

Incomplete statement. The equation on the left is always true, regardless of the distance between *X* and *C*, but the second equation is only approixmately true when *X* is close to *C.* In fact, $XCF = BCN' + CBX$, and $CBX \to 0$ when $X \to C$. See Fig 26-4.

… noting that

$$EXC = ECN = \theta_i, \quad \text{and} \quad XCF \approx BCN' = \theta_r \text{ when } X \text{ is near } C,$$

we have …

I:32-5, par 1

… then the energy we receive can be found by compounding the two complex number vectors A_1 and A_2, one at angle ϕ_1 and the other at angle ϕ_2 (as we did in Chapter 30) …

Incorrect reference.

… then the energy we receive can be found by compounding the two complex number vectors A_1 and A_2, one at angle ϕ_1 and the other at angle ϕ_2 (as we did in Chapter 29) …

I:32-7, par 4

The total amount of energy that would pass through this surface σ in a given circumstance is proportional both to the incoming intensity and to σ, and would be

$$P = \ldots \tag{32.18}$$

Inaccurate statement. P is power, not energy.

The total amount of energy that would pass through this surface σ in a given circumstance is proportional both to the incoming intensity and to σ, and the total power would be

$$P = \ldots \tag{32.18}$$

I:33-5, par 5

We know that is is not possible to …

Typographical error ('is' vs. 'it').

We know that it is not possible to …

I:34-3, par 5

From Eq. (12.10) we know that the force on a particle in a magnetic field is given by…

Incorrect reference.

From Eq. (28.2) we know that the force on a particle in a magnetic field is given by…

I:38-2, par 4

Then after it has come out through the hole, we know the position vertically—the y-position—with considerable accuracy—namely $\pm B$.

In III:2 where I:38 is reproduced, there is an informative footnote at this point.

Then after it has come out through the hole, we know the position vertically—the y-position—with considerable accuracy—namely $\pm B$. †

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† More precisely, the error in our knowledge is $\pm B/2$. But we are now only interested in the general idea, so we won't worry about factors of 2.

I:38-6, par 2

The spread of momentum is roughly h/a because of the uncertainty relation,

Wrong constant (‘h’ vs. ‘$\hbar$’).

The spread of momentum is roughly $\hbar/a$ because of the uncertainty relation,

I:38-6, par 2

—but the momenta must be of the order $p \approx h/a$.

Wrong constant (‘h’ vs. ‘$\hbar$’).

—but the momenta must be of the order $p \approx \hbar/a$.

I:38-6, par 2

Then the kinetic energy is roughly $\frac{1}{2}mv^2 = p^2/2m = h^2/2ma^2$.

Wrong constant (‘h’ vs. ‘$\hbar$’).

Then the kinetic energy is roughly $\frac{1}{2}mv^2 = p^2/2m = \hbar^2/2ma^2$.

I:38-6, Eq 38.10

$$E = h^2/2ma^2 - e^2/a . \tag{38.10}$$

Wrong constant (‘h’ vs. ‘$\hbar$’).

$$E = \hbar^2/2ma^2 - e^2/a . \tag{38.10}$$

I:38-6, Eq 38.11

$$E = -h^2/ma^3 + e^2/a^2 , \tag{38.11}$$

Wrong constant (‘h’ vs. ‘$\hbar$’).

$$E = -\hbar^2/ma^3 + e^2/a^2 , \tag{38.11}$$

I:38-6, Eq 38.12

$$a_0 = h^2/me^2 = 0.528 \text{ angstrom} = 0.528 \times 10^{-10} \text{ meter.} \tag{38.12}$$

Wrong constant (‘h’ vs. ‘$\hbar$’).

$$a_0 = \hbar^2/me^2 = 0.528 \text{ angstrom} = 0.528 \times 10^{-10} \text{ meter.} \tag{38.12}$$

I:38-6, Eq 38.13

$$E_0 = -e^2/2a_0 = -me^4/2h^2 = -13.6 \text{ ev.} \tag{38.13}$$

Wrong constant (‘h’ vs. ‘$\hbar$’).

$$E_0 = -e^2/2a_0 = -me^4/2\hbar^2 = -13.6 \text{ ev.} \tag{38.13}$$

I:43-10, par 2

… where $(\gamma-1)kT$ is the average energy of a molecule at the temperature T.

Mathematical error. [By Eq. 39.11 $PV=(\gamma-1)U$, by Eq. 39.12 $PV = NkT$, and for an ideal gas, $U = Nu$, where u is the average kinetic energy of a molecule.]

… where $kT/(\gamma-1)$ is the average energy of a molecule at the temperature T.

I:46-1, Title

Ratchet and pawl

Needs a footnote. Since the engine is *simultaneously* in contact with resevoirs at different temperatures, it can never work in a reversible way, nor achieve the efficiency of a Carnot cycle, not even in the limit of zero power, as claimed by Feynman. There is an (unaccounted for) irreversible heat transfer from the warmer gas (in the vane box) to the cooler gas (in the ratchet and pawl box), which implies that the process is only quasistatic, not reversible. See Parrando and Espanol, Am. J. Phys **64**(9),1125 (1996).

Ratchet and pawl*

*See Parrando and Espanol, Am. J. Phys **64**(9),1125 (1996) for a critical analysis of this chapter.