Errata Sheet for Herbert Goldstein's *Classical Mechanics*, Second Edition (1980)

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Below are some of the more prominent errors from Herbert Goldstein's *Classical Mechanics* (Copyright 1980, ISBN 0–201–02918–9), a text used in almost every graduate physics program in the U.S. and referenced by many practicing engineers and physicists worldwide. This errata sheet is probably not complete. If additional errors or problems are found in *Classical Mechanics*, please send them to Forrest Hoffman via electronic mail at `forrest@esdhof.esd.ornl.gov` or to Michael Unseren at `myu@mars.epm.ornl.gov`. If you do not have access to electronic mail, send corrections to Forrest Hoffman, Oak Ridge National Laboratory, MS 6036, Oak Ridge TN 37831–6036. If you would like to receive revised copies of this errata sheet in the future, please send mail to Forrest Hoffman and you will be added to the mailing list. This errata sheet may be freely distributed so long as the information above remains with it.

- Page 8, $\mathbf{v}'$ equation, middle of page†:

$$\mathbf{v}'_i = \frac{d\mathbf{r}'_i}{dt}$$

- Page 18, equation (1–48):

$$\begin{aligned}\sum_i \mathbf{F}_i \cdot \delta\mathbf{r}_i &= \sum_{i,j} \mathbf{F}_i \cdot \frac{\partial \mathbf{r}_i}{\partial q_j}\delta q_j \\ &= \sum_j Q_j \delta q_j, \end{aligned} \qquad (1-48)$$

- Page 19, above equation (1–51):

$$\begin{aligned}\frac{d}{dt}\left(\frac{\partial \mathbf{r}_i}{\partial q_j}\right) &= \frac{\partial \dot{\mathbf{r}}_i}{\partial q_j} = \sum_k \frac{\partial^2 \mathbf{r}_i}{\partial q_j \partial q_k}\dot{q}_k + \frac{\partial^2 \mathbf{r}_i}{\partial q_j \partial t}, \\ &= \frac{\partial \mathbf{v}_i}{\partial q_j}, \end{aligned}$$

- Page 19, above equation (1–52):

$$\sum_j \left\{ \frac{d}{dt}\left(\frac{\partial}{\partial \dot{q}_j}\left(\sum_i \frac{1}{2} m_i v_i^2\right)\right) - \frac{\partial}{\partial q_j}\left(\sum_i \frac{1}{2} m_i v_i^2\right) - Q_j \right\} \delta q_j.$$

- Page 24, equation (1–69):

$$\begin{aligned} Q_j = \sum_i \mathbf{F}_{if} \cdot \frac{\partial \mathbf{r}_i}{\partial q_j} &= -\sum \nabla_v \mathcal{F} \cdot \frac{\partial \mathbf{r}_i}{\partial q_i} \\ &= -\sum \nabla_v \mathcal{F} \cdot \frac{\partial \dot{\mathbf{r}}_i}{\partial \dot{q}_j}, \qquad \text{by } (1-51), \\ &= -\frac{\partial \mathcal{F}}{\partial \dot{q}_j}. \end{aligned} \qquad (1-69)$$

† a dagger indicates an error in both the corrected 2nd printing and later printings of the second edition.

• Page 45, equation (2–19):

$$I = \int_1^2 L\left(q_i, \dot{q}_i, t\right) dt \qquad (2-19)$$

• Page 60, equation reference below equation (2–51)†:

and (2–51) can be rewritten as

• Page 72, footnote†:

Formally: $\dot{\mathbf{r}} = \dot{r}\mathbf{n}_r + r\dot{\theta}\mathbf{n}_\theta$, hence $\mathbf{r} \times \dot{\mathbf{r}} = 0$ requires $\dot{\theta} = 0$.

• Page 75, below equation (3–20):

E, l, r_0, θ_0. These constants are not the only ones that can be considered. We

• Page 77, below equation (3–15′)†:

(For positive k the minus sign ensures that the force is *toward* the center of force.)

• Page 87, equation (3–36):

$$\theta = \int_{r_0}^{r} \frac{dr}{r^2\sqrt{\frac{2mE}{l^2} - \frac{2mV}{l^2} - \frac{1}{r^2}}} + \theta_0 \qquad (3-36)$$

• Page 91, above equation (3–43), equation (3–43), and equation (3–43′)†:

$$\left.\frac{d^2V'}{dr^2}\right|_{r=r_0} = -\left.\frac{df}{dr}\right|_{r=r_0} + \frac{3l^2}{mr_0^4} > 0.$$

$$\left.\frac{df}{dr}\right|_{r=r_0} < -\frac{3f\left(r_0\right)}{r_0}, \qquad (3-43)$$

$$\left.\frac{d\ln f}{d\ln r}\right|_{r=r_0} > -3. \qquad (3-43')$$

• Page 131, above equation (4–5):

$$\mathbf{i} = (\mathbf{i}\cdot\mathbf{i}')\,\mathbf{i}' + (\mathbf{i}\cdot\mathbf{j}')\,\mathbf{j}' + (\mathbf{i}\cdot\mathbf{k}')\,\mathbf{k}'$$

• Page 149, equation (4–54):

$$\delta = -\alpha^* \frac{\beta}{\gamma^*}, \qquad (4-54)$$

• Page 157, section number in heading at the top of the page:

4–5 THE CAYLEY-KLEIN PARAMETERS AND RELATED QUANTITIES **157**

• Page 159, sentence above equation (4–82)†:

homogeneous, the Eqs. (4–81) can have a nonzero, nontrivial solution only when the determinant of

• Page 176, $\omega_{x'}$ and $\omega_{y'}$ equations in equation (4–125):

$$\begin{aligned}\omega_{x'} &= \dot{\phi}\sin\theta\sin\psi + \dot{\theta}\cos\psi \\ \omega_{y'} &= \dot{\phi}\sin\theta\cos\psi - \dot{\theta}\sin\psi\end{aligned} \tag{4-125}$$

• Page 186, ω_x equation in problem 19:

$$\omega_x = \dot{\theta}\cos\phi + \dot{\psi}\sin\theta\sin\phi,$$

• Page 189, second paragraph, seventh line:

almost all problems soluble in practice will allow for such a separation. In such case

• Page 192, equation (5–10):

$$T'_{ijk\ldots}(\mathbf{x}') = a_{il}a_{jm}a_{kn}\ldots T_{lmn\ldots}(\mathbf{x})\,. \tag{5-10}$$

• Page 196, third equation:

$$I = \frac{2T}{\omega^2}$$

• Page 197, above last equation†:

The inertia tensor for the origin O, in the dyadic form of Eq. (5–16), can be written

• Page 198, second equation:

$$I_{xy} = I_{yx}$$

• Page 211, footnote equation†:

$$\dot{\boldsymbol{\omega}} = \boldsymbol{\Omega} \times \boldsymbol{\omega},$$

• Page 212, second equation†:

$$\Omega = \frac{\omega_3}{305.81039} \approx \frac{\omega_3}{306}$$

• Page 212, second sentence below second equation†:

of precession of approximately 306 days or about 10 months. If some circumstance disturbed the

• Page 213, equation (5–50):

$$T = \frac{I_1}{2}\left(\dot{\theta}^2 + \dot{\phi}^2\sin^2\theta\right) + \frac{I_3}{2}\left(\dot{\psi} + \dot{\phi}\cos\theta\right)^2, \tag{5-50}$$

• Page 221, below equation (5–77b):

$\theta, \phi, \psi, \dot{\theta}, \dot{\phi}$, and say, either $\dot{\psi}$ or ω_3 at the time $t = 0$. Because they are cyclic the

• Page 227, middle paragraph†:

nonvanishing correction term in Eq. (5–84) to the potential for a sphere. Now, the

• Page 228, equation (5–87)†:

$$V = -\frac{GMm}{r} + \frac{GM}{2r^3}\left[3I_r - (I_1 + I_2 + I_3)\right]. \tag{5-87}$$

• Page 228, equation (5–88)†:

$$V = -\frac{GMm}{r} + \frac{GM\left(I_3 - I_1\right)}{r^3} P_2\left(\gamma\right). \qquad (5-88)$$

• Page 229, equation (5–89)†:

$$V_2 = \frac{GM\left(I_3 - I_1\right)}{r^3} P_2\left(\gamma\right). \qquad (5-89)$$

• Page 240, equation in problem 19b†:

$$\sin\theta' = \frac{\Omega}{\dot{\phi}} \sin\theta'',$$

• Page 241, problem 25, sixth line†:

To prove this statement, calculate θ and $\dot{\phi}$ as a function of time for a heavy symmetrical

• Page 241, problem 25, Ω equation†:

$$\Omega = \frac{I_3 - I_1}{I_1}\omega_3$$

• Page 248, fourth line†:

and subtract the result from the similar product of Eq. (6–16) from the left with $\mathbf{a}_l^\dagger$.

• Page 256, equation, middle of the page:

$$\boldsymbol{\eta} = \tilde{\mathbf{B}}\mathbf{y}, \qquad \tilde{\boldsymbol{\eta}} = \tilde{\mathbf{y}}\mathbf{B},$$

• Page 259, equation (6–53)†:

$$|\mathbf{V} - \omega^2\mathbf{T}| = \begin{vmatrix} k - \omega^2 m & -k & 0 \\ -k & 2k - \omega^2 M & -k \\ 0 & -k & k - \omega^2 m \end{vmatrix} = 0. \qquad (6-53)$$

• Page 276, last paragraph†:

On the other hand, the transformation represented by Eqs. (7–2) and (7–4),

• Page 277, second paragraph, ninth line†:

systems moving uniformly relative to each other. Measurements made entirely

• Page 278, second paragraph, third and fourth lines†:

coincide at zero time, as seen by observers in both systems. Let one system, call it the primed system, move uniformly with velocity $\mathbf{v}$ relative to the other, unprimed

• Page 285, equation (7–30)†:

$$L_{44} = \left(1 - \beta^2\right)^{-\frac{1}{2}} \equiv \gamma. \qquad (7-30)$$

• Page 300, fifth line from the bottom†:

measured in the rest system is always shorter than the corresponding time interval

• Page 311, equation (7–103)†:

$$P_\mu P_\mu = -\left(m_1^2 + m_2^2\right) c^2 + 2p_{1\mu}p_{2\mu}. \qquad (7-103)$$

• Page 344, above equation (8–17)†:

q and t. The conjugate momenta, considered as a column matrix $\mathbf{p}$, is then by Eq.

• Page 350, above equation (8–41)†:

$\dot{x}'$, with the single component of $\mathbf{a}$ being mv_0. The new Hamiltonian is now

• Page 363, below equation (8–70)†:

Equations (8–69) and (8–70) are exactly Hamilton's equations of motion, Eqs.

• Page 383, above equation (9–15)†:

rather than $\dot{Q}_i$. This can be accomplished by writing F in Eq. (9–11) as

• Page 385, q_2 equation†:

$$q_2 = -\frac{\partial F'}{\partial p_2},$$

• Page 431, P equation in problem 5:

$$P = \frac{\alpha q^2}{2}\left(1 + \frac{p^2}{\alpha^2 q^2}\right)$$

• Page 607, elements (3,1) and (3,2) in equation (B–3y)†:

$$\mathbf{A} = \begin{pmatrix} -\sin\psi\sin\phi + \cos\theta\cos\phi\cos\psi & \sin\psi\cos\phi + \cos\theta\sin\phi\cos\psi & -\cos\psi\sin\theta \\ -\cos\psi\sin\phi - \cos\theta\cos\phi\sin\psi & \cos\psi\cos\phi - \cos\theta\sin\phi\sin\psi & \sin\psi\sin\theta \\ \sin\theta\cos\phi & \sin\theta\sin\phi & \cos\theta \end{pmatrix} \qquad (\mathrm{B}-3\mathrm{y})$$