Comment on 'From Moon-fall to motions under inverse square laws'

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2010 Eur. J. Phys. 31 L97
(http://iopscience.iop.org/0143-0807/31/6/L03)

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Comment on ‘From Moon-fall to motions under inverse square laws’

S Rojas
Physics Department, Universidad Simón Bolívar, PO BOX 89000, Caracas 1080A, Venezuela
E-mail: srojas@usb.ve

Received 15 June 2010, in final form 12 September 2010
Published 14 October 2010
Online at stacks.iop.org/EJP/31/L97

Abstract
A comment is made on the paper by Foong (2008 Eur. J. Phys. 29 987).

Reading with interest Foong’s paper [1], we find it necessary to advise the interested and active instructor of physics that the dimensionless equation (7) or its equivalent dimensional equation (9) in the paper is only valid for the gravitational interaction between two point particles. In the case considering the gravitational interaction between spherical bodies as approximations of the Moon, the Earth and the Sun, the equations mentioned are only valid at points outside each mass distribution [2]. Correspondingly, the quantity representing distance in these equations, either the dimensionless $x'$ of equation (7) or the dimensional $x$ of equation (9), cannot take the value of zero, as is implied by the computations leading to equation (8) on page 990 and in the steps performed on examples 2 and 3 on page 993 of the article.

In fact, if one considers the interacting bodies as rigid spheres and representing by $R_T$, $R_M$ and $R_S$ respectively the radius of the Earth, the Moon and the Sun, the lowest value that the dimensional $x$ can take in equation (9) is $x = (R_T + R_M)$ (interaction Earth–Moon) or $x = (R_T + R_S)$ (interaction Earth–Sun). Moreover, the fact that $x$ cannot be zero released the speed of the falling body, in equation (6), from taking an infinite value.

Nevertheless, when the aforementioned corrections are implemented, the obtained numerical values are very close to the ones reported in the article [1]. Specifically, using the values $R_T = 6.378 \times 10^3$ Km, $R_M = 1.738 \times 10^3$ Km, $R_S = 6.960 \times 10^5$ Km, and the numerical values provided in Foong’s paper at the beginning of section 2.6, page 993, the results for the dimensional time, using either equation (9) or equation (7) and (10) in the paper, are shown in table 1 (computed as if each numerical value has four significant figures): the computed relative percent error $\epsilon$ indicates that both values are practically the same. The active student should bear in mind, however, that a very small difference between two numerical factors can be used to decide among competing physical theories or models. An example illustrating this idea can be drawn from the prediction of the perihelion shift of the planet Mercury and the deflection of light by the Sun. Einstein’s general relativity theory is the winner on the basis that its predictions are in agreement with the results of increasingly accurate experiments measuring such small quantities [3].
Table 1. Results for dimensional time, computed from Foong’s paper [1].

<table>
<thead>
<tr>
<th>Example</th>
<th>$\tau_{\text{days}}$</th>
<th>$\tau_{\text{days}}$</th>
<th>Percent error $\epsilon = | \frac{\tau - \tau}{\tau} | \times 100$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Example 2</td>
<td>4.843</td>
<td>4.836</td>
<td>0.2%</td>
</tr>
<tr>
<td>Example 3</td>
<td>64.55</td>
<td>64.54</td>
<td>0.02%</td>
</tr>
</tbody>
</table>

Finally, in the case of an object going through the centre of the attracting spherical body, the gravitational interaction inside the sphere needs to be taken into account. One could think of a small object travelling along a thin orifice across a diameter of the spherical mass distribution, as illustrated on page 376 of reference [2]. Certainly, this is an unrealistic scenario in the case of the Moon falling towards the Earth or the Earth falling towards the Sun.

References