Journal of Physics Special Topics
An undergraduate physics journal

P2_10 Leap Year? Get out of Here! Part 2

C. Murgatroyd, D. Mott, J. Stinton, C. Kinsman

Department of Physics and Astronomy, University of Leicester, Leicester, LE1 7RH

December 6, 2021

Abstract

The aim of this paper was to determine by how much Earth's rotation would have to slow down so that each orbital year was exactly 365 days, which would therefore remove the leap year. This was found to require the period of Earth's rotation to decrease by 0.27% which corresponds to removing 1.1763×10^{27} J of energy from the Earth. It was determined that this is not feasible because current energy production is insufficient, and also because we would have no mechanism of applying this force to the Earth even if we did meet the energy requirements.

Introduction

The Gregorian calendar is the standard calendar used across most of the world, however, it has to make some exceptions to account for leap years. Leap years occur because the Earth's rotational period, the measurement for a day, and the Earth's orbital period, the measurement of a year, are not exact multiples of each other. If they were exact multiples of each other then there would be a way to construct a calendar that was the same each year, without any leap years. As such, this paper aims to explore the physics of changing the rotational period of the Earth to make it an exact multiple of the year to remove the leap year from the calendar.

Theory

The angular velocity of the Earth can be calculated using:

$$\omega = \frac{2\pi}{T} \tag{1}$$

where T is the rotational period. The energy of the Earth's orbit for a given angular velocity, corresponding to its period, is given by the kinetic rotational energy of a spherical body [1]:

$$E_{\text{Earth}} = \frac{1}{2} I \omega^2 \tag{2}$$

where I is the Moment of Inertia, and ω is the angular velocity value of the Earth's orbit around its axis.

The amount of energy required to slow the Earth's rotation to remove the leap year can be calculated by finding the difference in the kinetic rotational energy of the Earth before and after changing the period. The energy difference is given by:

$$\Delta E = E_i - E_f \tag{3}$$

Results

The Earth's current rotational period for a full stellar day takes $T_i = 86164$s [2]. Substituting this result into Eq. (1) gives an angular velocity of $\omega_i = 7.2921 \times 10^{-5}$ rad s^{-1}. For the Earth day to be an exact multiple of the year, the rotational period should be equal to $T_f = 86400$s, which is the conventional measurement of the time elapsed in a full day. The new angular velocity of the Earth when substituting this period