31. (a) A complete revolution is an angular displacement of $\Delta\theta = 2\pi$ rad, so the angular velocity in rad/s is given by $\omega = \Delta\theta/T = 2\pi/T$. The angular acceleration is given by

$$\alpha = \frac{d\omega}{dt} = -\frac{2\pi}{T^2}\frac{dT}{dt} \ .$$

For the pulsar described in the problem, we have

$$\frac{dT}{dt} = \frac{1.26 \times 10^{-5}\,\text{s/y}}{3.16 \times 10^{7}\,\text{s/y}} = 4.00 \times 10^{-13} \ .$$

Therefore,

$$\alpha = -\left(\frac{2\pi}{(0.033\,\text{s})^2}\right)(4.00 \times 10^{-13}) = -2.3 \times 10^{-9}\,\text{rad/s}^2 \ .$$

The negative sign indicates that the angular acceleration is opposite the angular velocity and the pulsar is slowing down.

(b) We solve $\omega = \omega_0 + \alpha t$ for the time t when $\omega = 0$:

$$t = -\frac{\omega_0}{\alpha} = -\frac{2\pi}{\alpha T} = -\frac{2\pi}{(-2.3 \times 10^{-9}\,\text{rad/s}^2)(0.033\,\text{s})} = 8.3 \times 10^{10}\,\text{s} \ .$$

This is about 2600 years.

(c) The pulsar was born 1992 − 1054 = 938 years ago. This is equivalent to $(938\,\text{y})(3.16 \times 10^7\,\text{s/y}) = 2.96 \times 10^{10}$ s. Its angular velocity at that time was

$$\omega = \omega_0 + \alpha t = \frac{2\pi}{T} + \alpha t = \frac{2\pi}{0.033\,\text{s}} + (-2.3 \times 10^{-9}\,\text{rad/s}^2)(-2.96 \times 10^{10}\,\text{s}) = 258\,\text{rad/s} \ .$$

Its period was

$$T = \frac{2\pi}{\omega} = \frac{2\pi}{258\,\text{rad/s}} = 2.4 \times 10^{-2}\,\text{s} \ .$$