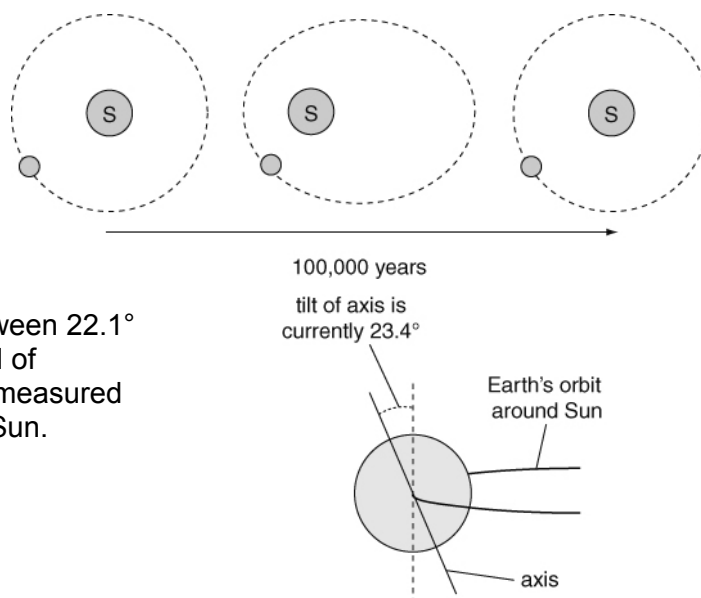


The Earth's orbit does not stay exactly the same over time. The Serbian astronomer Milutin Milankovitch (1879–1958) studied how changes in the Earth's orbit might affect the climate. He identified several different changes that repeat over different times. These changes are due to the effects of the gravity of other planets in the Solar System. Two of these cycles are shown below.

- A** The Earth's orbit varies from almost circular to elliptical and back to circular again over approximately 100 000 years.

A more elliptical orbit is a more 'eccentric' orbit.

The current eccentricity of the Earth's orbit is about $\frac{1}{4}$ of its maximum eccentricity, and the eccentricity is decreasing. The North Pole is tilted away from the Sun when the Earth is at the closest point in its orbit.



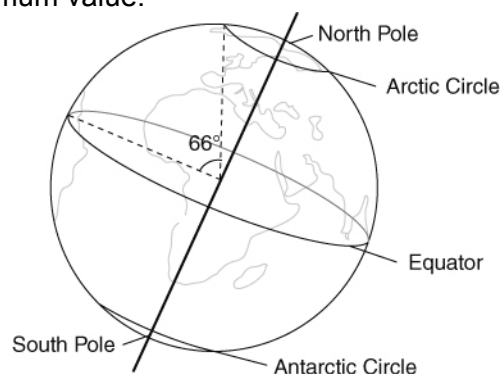
- B** The tilt of the Earth's axis changes between 22.1° and 24.5° and back again over a period of approximately 41 000 years. The tilt is measured relative to the Earth's orbit around the Sun.

- Which has most effect on temperatures on the Earth: the tilt of the Earth's axis or the changes in the distance of the Earth from the Sun as it goes around its orbit? Explain your answer.
- Briefly describe the differences between summer and winter in the northern hemisphere.
- Explain how the conditions described in your answer to question 2 will be different when:
 - the Earth's orbit becomes *more* elliptical
 - the tilt of the Earth's axis increases to its maximum value.

- 4** The Arctic Circle is a line of latitude 66.6° north of the Equator. Everywhere north of the Arctic Circle has at least one day each year when the Sun does not set.

The Arctic Circle is moving towards the North Pole by about 15 metres per year.

Is the Earth's tilt increasing or decreasing at the moment? Explain your answer.



- The tilts of the axes of the planets in the Solar System are all different. The tilt of Uranus' axis is approximately 90° . Describe how the conditions on Earth would change during a year if the Earth's axis was tilted at 90° .
- Suggest how the seasons on Uranus may be different to the seasons on Earth that you have described in question 5. (*Hint*: think about the effect of the different distances of Uranus and the Earth from the Sun.)

I can...

- describe how changes in the Earth's orbit and tilt affect the seasons
- use information about other planets to suggest what the seasons may be like there.