Seasons on other planets

Background information

The seasons on the planets of the Solar System are largely a reflection of the size of the difference between the maximum and minimum temperatures on each planet. This difference is caused by the combined influence of a number of factors:

1. **The distance of the planet from the Sun**
   If a planet is close to the Sun (eg. Mercury), the influence of the Sun's rays will be much greater than on planets far away (eg. dwarf planet Pluto). The Earth is quite close to the Sun, so the Sun has a large influence on temperatures on Earth.

2. **The rotation time of the planet**
   Planets that have a long rotation time (eg. Mercury) have a much longer daytime and night-time than planets with a short rotation time (eg. Jupiter). If the Sun is in the sky for a long time, that half of the planet will tend to become much hotter than if the Sun is in the sky for a short time. Similarly, long nights will cause much lower temperatures than short nights, as the half of the planet in darkness will have longer to cool down. The average daytime and night-time on Earth is quite short, so our rotation time has only limited influence on maximum and minimum temperatures.

3. **The composition and density of the planet's atmosphere**
   Planets with dense atmospheres (eg. Venus) will have little variation in temperature, as the atmosphere moderates heat gain and loss. Temperatures on planets with no atmosphere, or a very thin atmosphere (eg. Mercury) are not subject to this moderating influence. The Earth's atmosphere is of medium density – it filters the Sun's heat that comes through to the surface during the day and helps to retain heat when the Sun goes down.

4. **The axial tilt of the planet**
   If the axis of a planet has a moderate tilt (eg. Earth, Mars), or a large tilt (Uranus, Pluto) there will be a big seasonal variation in the length of day and night, especially at higher latitudes. For planets that are close to the Sun, this will cause a marked seasonal difference between temperatures in the two hemispheres.

   Earth's tilt of 23.5 degrees causes locations close to the poles to have around six months of daytime and six months of night-time. When the South Pole is tilted towards the Sun, it is the Southern summer with continuous daylight, and when the South Pole is tilted away from the Sun, it is the southern winter with continuous night time.

5. **The orbital eccentricity of the planet**
   The more elliptical the orbit of a planet, the more variation there will tend to be in temperature as the planet revolves around the Sun. When the planet's orbit takes it nearer the Sun, it will receive more heat than when it is further away. Mercury has a quite elliptical orbit, while Earth's orbit is almost circular.

Solar System statistics

Planet	Average distance from the Sun (millions of km)	Length of day (sunrise to sunrise)	Axis tilt (degrees)	Orbital eccentricity	Orbital path shape (approx)	Atmosphere density	Maximum & minimum temperature (degrees Celsius)
Mercury	57.9	176 days	0.01	0.21	Very elliptical	None	+427 (S) -173 (S)
Venus	108.2	117 days	177.4	0.01	Circular	Thick	+482 (S) mean
Earth	149.6	24 hours	23.5	0.02	Circular	Medium	+58 (S) -88 (S)
Mars	227.9	24.5 hours	25.2	0.09	Elliptical	Very thin	+20 (S) -140 (S)
Jupiter	779	9.9 hours	3.1	0.05	Elliptical	Very thick	-108 (C) mean
Saturn	1 434	10.7 hours	26.7	0.06	Elliptical	Very thick	-139 (C) mean
Uranus	2 873	From 17.2 hrs to 21 yrs.	97.8	0.05	Elliptical	Very thick	-197 (C) mean
Neptune	4 495	16.1 hours	28.3	0.01	Circular	Very thick	-201 (C) mean
(Dwarf Planet) Pluto	5 870	From 6.4 days to 62 yrs.	122.5	0.25	Very elliptical	Very thin	-225 (S) mean

(S) Surface (C) Cloud

Student activity

Study the background information about the factors influencing the seasons on other planets, together with the table of Solar System statistics (above).

Write a short paragraph about the seasons on each of the planets (one paragraph per planet). Explain the influence of each factor on temperature variations and seasons for each planet, noting where a factor tends to decrease temperature differences and where it tends to increase temperature differences.

You may wish to supplement your information with library and Internet research e.g. The Eight Planets: http://www.nineplanets.org/

If time is short, the planets can be divided between class members (one planet per group) and the results shared when everyone is finished.

Additional notes about seasons on other planets

Teachers:
The notes below about seasons on each planet provide additional information for the student activity. However, it is suggested that students first try to use the background information and table of Solar System statistics (above) without the benefit of the notes below.

- **Mercury** is the closest planet to the Sun. Its climate varies considerably throughout its year because it moves in a highly elliptical path. This means that at times it is much closer to the Sun than at other times. It does not have any atmosphere and has no protection from the Sun. During the day it gets really hot and during the night it gets really cold. Mercury has no tilt, so its seasons are caused by its highly elliptical path around the Sun.

- **Venus** is the second closest planet to the Sun. Its orbit does not cause the seasons because it is nearly circular. It has a tilt of only three degrees (in the opposite direction to the other planets) so temperatures across the planet do not vary much throughout a Venus year. The climate on this planet is always hot because it is relatively close to the Sun and has a thick atmosphere that keeps temperatures stable. You could say that Venus hardly has any seasons at all.

- **Mars** is the fourth closest planet to our Sun. This planet can be considered to have only two seasons (summer and winter) that vary greatly in temperature. The planet's elliptical path and its significant tilt produce the seasons. The fact that Mars has a very thin atmosphere also contributes to the extreme temperature variations.

- **Jupiter** has a tilt of only three degrees and has a very thick atmosphere (being one of the gas giants). Its path around the Sun is elliptical, so you might expect the temperature to vary along its orbit. However, it is very far from the Sun, so the temperature change is small. Jupiter is always very cold. The very thick atmosphere keeps the cold temperatures very stable. You could say that Jupiter does not have any seasons.

- **Saturn** is one of the gas giants. It has a tilt as well as an elliptical path around the Sun. However, since it is very far away from the Sun, it is always very cold and its thick atmosphere keeps it that way.

- **Uranus** has an elliptical orbit but is a long way from the Sun so it experiences extremely cold conditions all year round. It has a very thick atmosphere (being another of the gas giants) and so the temperature remains very cold throughout its year. It has a tilt of about 98 degrees, practically spinning on its side. Its daytime lasts for half of its year and night-time for the other half.

- **Neptune**'s orbit is nearly circular, and it has a tilt of about 28 degrees. However, Neptune is far away from the Sun, so temperatures are always extremely cold. Its atmosphere is very thick and keeps the climate icy cold.

- **Pluto** (a dwarf planet) is very far from the Sun so temperatures are always extremely cold. Even though its path around the Sun is very elliptical, and its atmosphere is extremely thin, the distance from the Sun makes it extremely cold all the time.