Chapter 6

Space physics

6.1 Earth and the Solar System

01. 0625_s23_qp_41 Q: 10

Pluto is a dwarf planet. Fig. 10.1 shows the direction of motion of Pluto as it follows its elliptical orbit around the Sun.

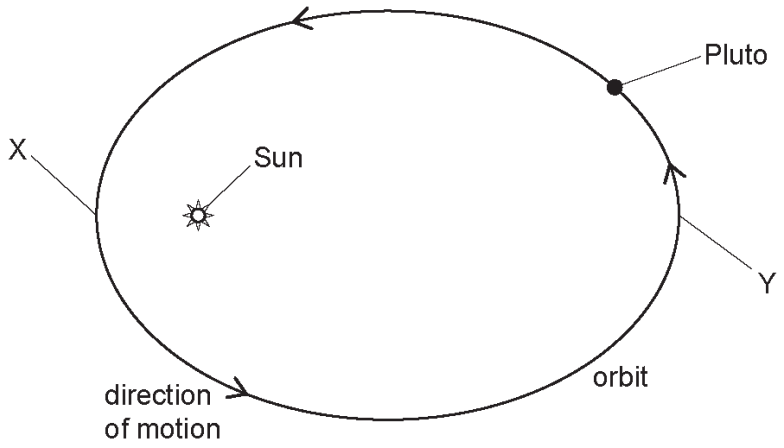

Fig. 10.1 (not to scale)

(a) Point X is the point in the orbit closest to the Sun and point Y is the point furthest away.

The orbital speed of Pluto varies as it orbits the Sun.

(i) Describe how the speed of Pluto varies as it moves from X to Y and then back to X.

.....

..... [1]

(ii) Explain, in terms of energy transfers, why the speed of Pluto varies in this way.

.....

.....

.....

..... [3]

(b) The average temperature on the surface of Pluto is 43 K.

(i) Convert this temperature to a value in degrees Celsius (°C).

temperature = ... °C [1]

(ii) Pluto has a white surface, as shown in Fig. 10.2. As Pluto rotates, the white surface alternately faces towards and away from the Sun.

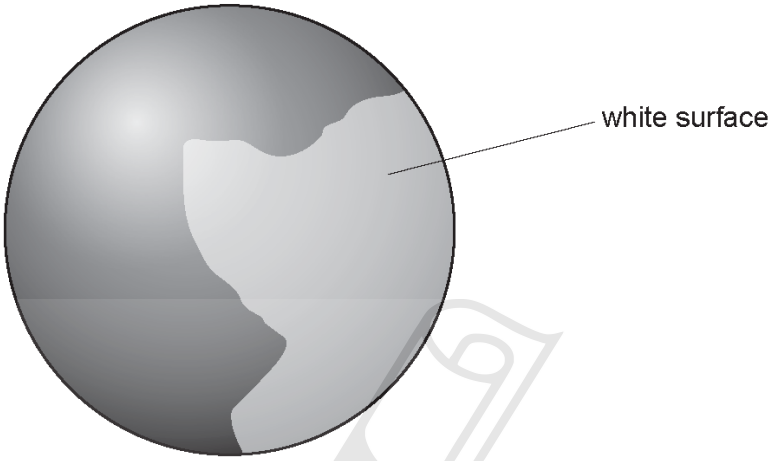

Fig. 10.2

Explain how this affects the temperature of Pluto as it rotates on its own axis.

.....

.....

.....

..... [2]

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Fig. 9.1 shows the Sun as the central dot and the planets Saturn, Jupiter and Earth labelled S_0, J_0 and E_0. The planets orbit the Sun anticlockwise. From the Earth's orbit, the planets appear aligned.

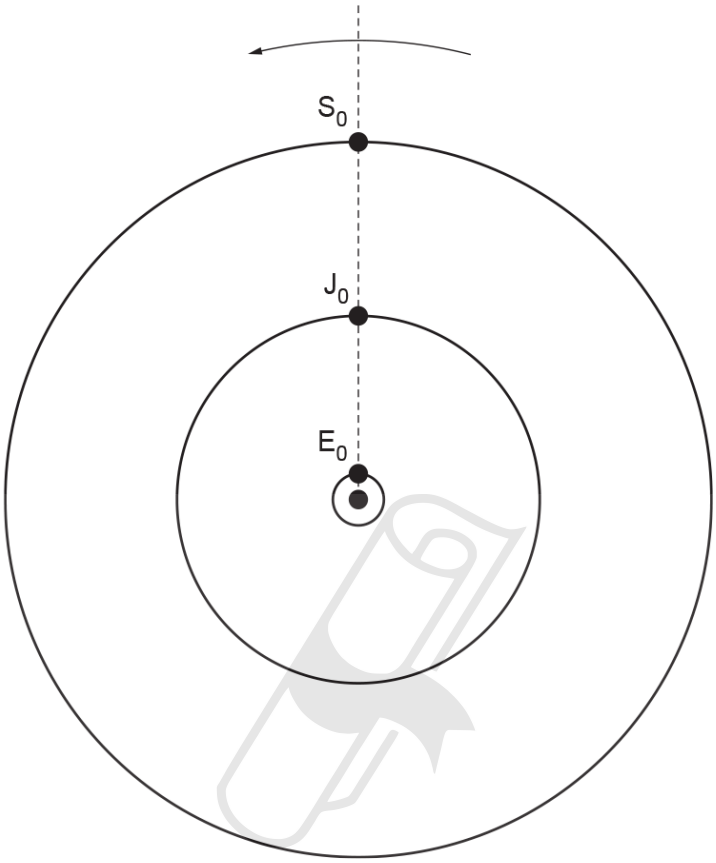

Fig. 9.1 (not to scale)

Assume that Saturn takes 30 years to orbit the Sun and that Jupiter takes 12 years to orbit the Sun.

(a) On Fig. 9.1, mark the positions of Saturn and Jupiter 5.0 years after the original positions shown.

Label these positions S_1 and J_1. Show your working.

[3]

(b) **(i)** On Fig. 9.1, mark the positions of Saturn and Jupiter 20 years after the original positions shown in Fig. 9.1.

Label these positions S_2 and J_2.

[1]

(ii) State what is observed from the Earth's orbit after 20 years.

.....

..... [1]

(c) **(i)** Choose **two** words from the list to describe **each** planet.

gaseous **large** **rocky** **small**

Jupiter .....

Earth .....

[1]

(ii) The average density of Jupiter is much less than that of the Earth.
The gravitational field strength at the surface of Jupiter is greater than that at the surface of the Earth.

Explain how these differences in density and in gravitational field strength are consistent with your answers to **(c)(i)**.

density

.....

.....

gravitational field strength

.....

.....

[3]

(d) The average density of Jupiter is $1300\,kg/m^3$ and its volume is $1.4 \times 10^{15}\,km^3$.

Calculate the mass of Jupiter.

mass = ... [3]

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Table 9.1 gives information about three planets in the Solar System.

Table 9.1

planet	mass / 10^{24} kg	average distance from Sun / 10^{6} km	orbital period / days	gravitational field strength at surface / N/kg
Earth	5.97	149.6	365.2	9.8
Jupiter	1898	778.6	4331	23.1
X	4.87	108.2	224.7	8.9

(a) State the name of planet X.

..... [1]

(b) Describe the relationship shown in Table 9.1 between the mass of a planet and the gravitational field strength at its surface.

.....

..... [1]

(c) Explain why 'distance from Sun' in Table 9.1 is an average value.

.....

..... [1]

(d) Show that the average orbital speed of the Earth is approximately 30 km/s.

[3]