The Planets

Teacher's Notes and Answer Key

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SCIENCE

This worksheet is designed for at least two lessons, including one whole lesson devoted to the students' presentations, and will take between two and four hours to complete, depending on the number of students. In addition to this, students will need time outside of class to work together on preparing their presentations.

The material is suitable for upper secondary school students who are learning about the planets. It presupposes an awareness of basic algebra, and familiarity with the concept of expressing large numbers as multiples of powers of ten.

There is a separate PowerPoint template for the students' presentations, which they should be given before starting the project work.

1 Mathematical formulae — Reading, Writing

Aims

- To revise how to apply mathematical formulae
- To learn how to read and talk about simple formulae in English

Students complete the task in pairs, then check with the whole class.

Key

1 formula; 2 mass; 3 volume; 4 density; 5 equals; 6 over; 7 speed; 8 distance; 9 time; 10 equation; 11 calculate

2 Calculations — Speaking

Aims

- To calculate values by applying the formulae in 1
- To speak about and manipulate the large numbers involved

Before students begin the calculations, draw their attention to the Useful Language box, and remind them how to read numbers like "5.68×10^{26}" (five point six eight times ten to the twenty-sixth), and what they represent (the power of ten is the number of figures that must appear after where the decimal point is written, so this number is 568,000,000,000,000,000,000,000,000).

If necessary, do the first question together with the whole class so that they are comfortable about the calculations.

Key

1. Applying d = $\frac{m}{v}$, divide the mass by the volume to find the density. It is easier if you first divide both the mass and the volume by 10^{18} (which does not change the ratio between them) leaving 5,974,000/1,083 = **5,516 kg/ m³**.

2. Applying d = $\frac{m}{v}$ again (notice that this time the volume is given first), and dividing both mass and volume by 10^{20}, calculate 5,680,000/9,048 = **627.8 kg/m³**.

3. First, calculate the distance between the two orbits: 1,430,000,000 − 150,000,000 = 1,280,000,000 km. Applying t = $\frac{d}{s}$, divide this distance by the speed: 1,280,000,000 / 65,000 = 19,692.3 hours. Divide by 24 to find the number of days – 820.5 – then by 365.25 to find the number of years: 2.246. This is about **2 years and 3 months**.

4. Again, apply t = $\frac{d}{s}$, and divide the distance by the speed to find the time taken. First, divide both numbers by 10^7, then calculate 1,620/108 = **15 hours**.

3 Terminology — Vocabulary, Pronunciation

Aims

- To pre-teach some vocabulary for the reading passage
- To illustrate some common patterns for forming adjectives

Students can do this alone, then check in pairs. When you give class feedback, elicit the spelling of each word as you write it on the board, and then drill the pronunciation.

Key

1. blanketed /blæŋkɪtɪd/

2. icy /ˈaɪsi/

3. rocky /ˈrɒki/

4. swirling /ˈswɜːlɪŋ/

5. gravitational /ˌgrævɪˈteɪʃnəl/

6. reddish /redɪʃ/

7. tilted /tɪltɪd/

4 The solar system — Reading

Aims

- To learn about the planets and the solar system
- To practise extensive reading with a lengthy text
- To look for specific information in the text

Students work alone and write their answers. This is an opportunity to grade the students' writing as well as their understanding of the content.

Key

1. Gravity is a force that attracts all objects to all other objects. It gets stronger if the objects are larger or closer together. It is the force that keeps the planets in orbit around the sun.

2. The giant planets are mostly made from gas, although it is thought that they have cores of rock and ice.

3. Europa is one of the 63 moons of Jupiter.

4. The Evening Star is actually the planet Venus.

5. Saturn and Uranus.

6. The rotation of the planet on its own axis: the side facing the sun is in daylight, and it is night on the side facing away from the sun.

5 Presentation — Writing, Speaking

Aims

- To consolidate learning of the information about the solar system
- To prepare and give a factual presentation

Divide the class into eight groups, one for each of the planets. To complete this task they will need time with a computer outside of class for internet research and to complete the presentation. You will need a computer and projector in class for the presentations themselves: be sure to allow plenty of class time.

Give each group a copy of the presentation template, and make sure they know how to find the information and images they need, and how to put them in.

When they come to make their presentation, make sure that the speakers in each group take turns so that everyone gets a chance to speak. If time is tight, you may want to call on just two or three groups to give their presentations: ideally you should find time for all eight of them.

The Planets

Francesca Costa

1 Mathematical formulae

Reading, Writing

Work in pairs. Fill the gaps with the words in the box.

calculate	density	distance	equals
equation	formula	mass	over
speed	time	volume	

If you already have some information about the planets, you can use a (1)__________ to work out other things you want to know. For example, if you know how much matter there is in a planet (its (2)__________, *m*), and you know how much space it takes up (its (3)__________, *v*), then you can calculate its (4)__________ (how thickly pressed together the material is) from:

$$d = \frac{m}{v}$$

We read this: "*d* (5)__________ *m* (6)__________ *v*". To find *d*, just divide *m* by *v*. Another example is used to calculate something's (7)__________ (*s*): divide the (8)__________ it has travelled (*d*) by the (9)__________ it has taken (*t*):

$$s = \frac{d}{t}$$

You can follow mathematical rules to rearrange an (10)__________ like this, in order to (11)__________ the value of a different variable. You can multiply both sides by *t* to find *d*:

$$st = d$$

Then you can divide both sides by *s* to find out how long you need to make the journey:

2 Calculations

Speaking

Work in pairs. Use the formulae in exercise 1 and the language in the Useful Language box below to do the calculations.

1. The mass of the Earth is 5.974×10^{24} kg.
   The volume of the Earth is 1.083×10^{21} m^3.

   What is the average density of the Earth in kg/m^3?

2. The volume of Saturn is 9.048×10^{23} m^3.
   The mass of Saturn is 5.68×10^{26} kg.

   What is the average density of Saturn in kg/m^3?

3. The Voyager space probes travel at about 65,000 km/h.
   Earth's orbit is (on average) 150,000,000 km from the sun.
   Saturn's orbit is (on average) 1,430,000,000 km from the sun.

   In reality the planets are always moving, so Voyager actually took four years to reach Saturn, using the planets' gravity fields and changing speed as a result. But if we could travel directly from one orbit to the other at a constant speed of 65,000 km/h, how much time would be needed just to travel from Earth's orbit to Saturn's orbit?

4. Voyager 1, which was launched in 1977, is now about 1.62×10^{10} km away from the Earth. The signals that it sends back to scientists here travel at the speed of light, 1.08×10^{9} km/h. How long does it take for a message to arrive?

Useful Language box

Useful Language

We need to multiply/divide … by … .

… times ten to the power of … means we need … figures after the decimal point.

That's … zeros.

We can divide both sides of the equation by …

That can't be right because …

3 Terminology

Vocabulary, Pronunciation

Add one of the endings in the box to each of these words, and match the resulting adjective with one of the definitions. Practise writing and saying the adjectives.

-ational	-ed	-ing	-ish	-y

blanket	gravity	ice	red	rock	swirl	tilt

1. covered with a thin layer
2. frozen, very cold
3. made of rock
4. moving quickly in circles
5. relating to the force of gravity
6. similar to red in colour
7. with one side lower than the other

Read about the solar system, and then answer the questions.

THE SOLAR SYSTEM

There are eight planets orbiting the sun. A planet's **orbital period** is the time it takes to complete one orbit around the sun (for the Earth this is one year). All the planets orbit around the sun because they are drawn to it by the force of gravity. Gravity, which was first explained by Isaac Newton, is the force that attracts one object to another, so it holds together the solar system, and hold you to the ground as well! The gravitational force between two objects increases as their mass increases and as they get closer.

In order to analyse the eight planets we can divide them into Gas (giant) planets and Rock (terrestrial) planets, according to what they are made of and their size. The **terrestrial planets** are Mercury, Venus, Earth and Mars. They are closer to the sun, are comparatively small, and have a small mass. They consist almost entirely of rocky materials. The **giant planets** are Jupiter, Saturn, Uranus and Neptune. These are far away from the sun, and are very big but have a low density. They have cores of icy and rocky materials, surrounded by swirling clouds of gases.

Mercury is the smallest planet in the solar system and the closest to the sun. Its surface temperature is about $-180^{\circ}C$ on the side facing away from the sun, and $430^{\circ}C$ on the day side. On Mercury there are cliffs and craters just like on Earth, and it is believed to have icy caps. It has no atmosphere (which is why the side facing away from the sun loses so much heat) and its inner core is composed of melted iron.

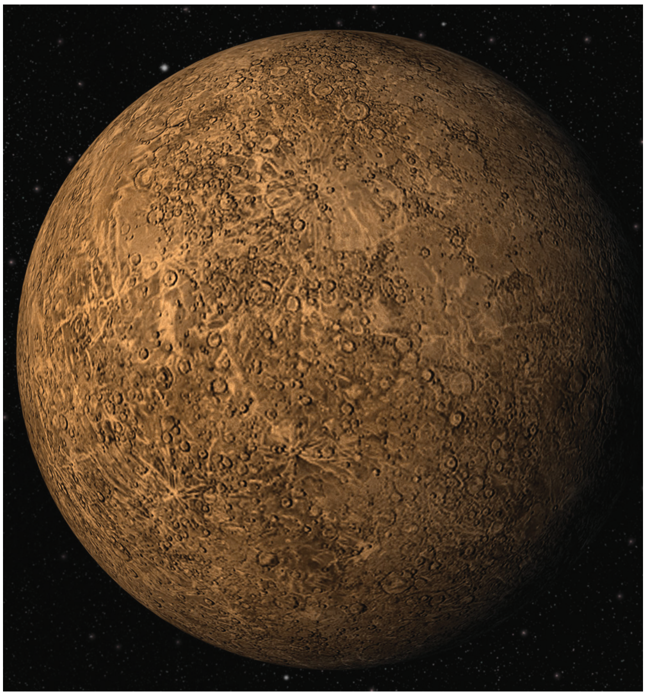

Figure 1. Mercury.

Venus is the second closest planet to the Sun, and is blanketed in a thick atmosphere of carbon dioxide, nitrogen and other gases. For this reason it is very hot – it can get to about 500°C on the surface. It has continuous volcanic activity. Venus has a core made of nickel. Because of the thick cloud cover Venus reflects sunlight well, and can easily be seen from Earth. It is sometimes called the Morning Star or the Evening Star, although of course it isn't really a star at all.

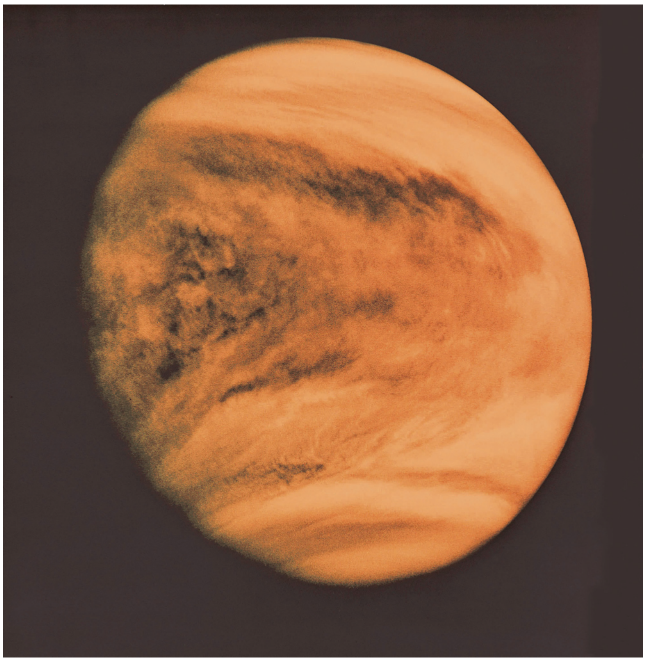

Figure 2. Venus.

Mars is known as the red planet because its surface appears to be reddish. It closely resembles a desert on Earth, and has got ice caps at its poles. It is the second smallest planet, and it has canyons and ancient rivers where there is thought to have once been water. It has got an iron and nickel core. It is the only other planet in the solar system that we have managed to land on – robots from NASA have travelled across it taking photos, giving us a clear idea of what the surface is like.

Figure 3. Mars.

Jupiter is the largest planet in the Solar System – its diameter is about eleven times that of the Earth. It is made of gas, and probably has a small rocky core. It has got 63 moons, including Europa, which is thought to have a giant water ocean beneath its icy crust. Jupiter is famous for a great swirling storm in its atmosphere known as the Great Red Spot – this storm alone is larger than the Earth.

Figure 4. Jupiter.

Saturn is also made of gas, and is the second largest planet. It has a hydrogen atmosphere, a rocky core, and 56 moons. The famous rings of Saturn are actually made of millions of small chunks of ice and other debris that are circling the planet – perhaps the remnants of a destroyed moon.

Figure 5. Saturn.

Uranus is a very big planet, with moons and several separate rings. It is made of rock and ice and has an atmosphere of hydrogen, helium and methane, which makes it look blue.

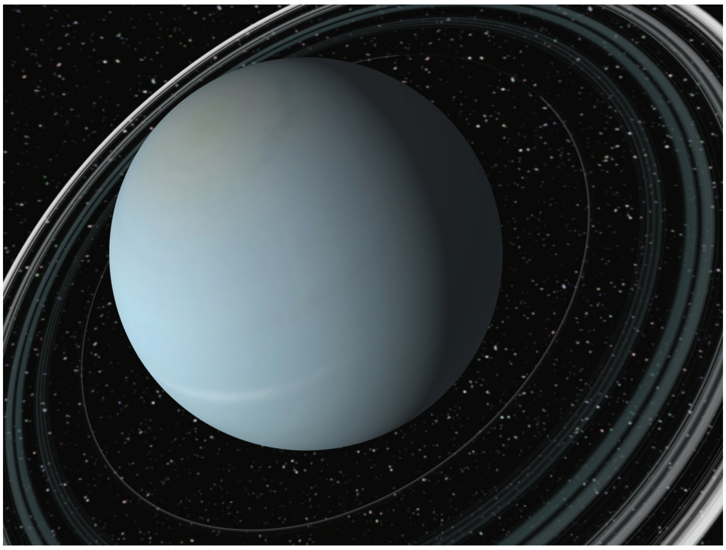

Figure 6. Uranus.

Neptune is also very large. It has got a metal core and an atmosphere of hydrogen and helium. As the furthest planet from the sun it is also the coldest – its surface temperature is thought to be about -230°C!

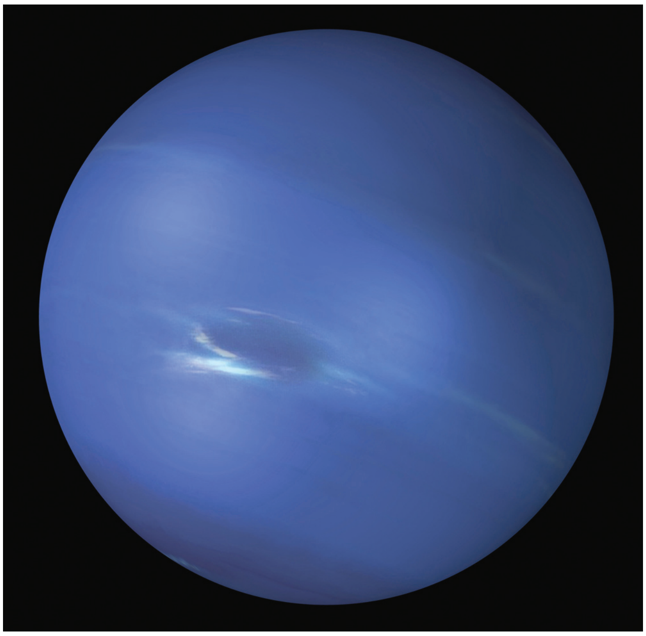

Figure 7. Neptune.

The last planet we'll look at is the Earth (although it is the third planet from the sun). The Earth takes 365 days (1 year) to make a full revolution around the sun. This, together with the fact that the planet is tilted on its axis, causes the change of seasons. When it is summer in the Northern hemisphere the Northern hemisphere is tilted towards the sun. At the same time it is winter in the Southern Hemisphere, as this part of the Earth is tilted away.

The **Earth** spins around its own axis once every 24 hours – this causes the day and night cycles.

Figure 8. Earth.

1. What is gravity?
2. What are the giant planets mostly made from?
3. Where is Europa?
4. What is the Evening Star?
5. Which planets have rings?
6. Which are the two smallest planets?
7. What causes day and night cycles on the planets?

5 Presentation — Writing, speaking

Work in groups. Prepare a presentation about one of the planets, using the PowerPoint template. Take turns to present the information to the class.