6.1 The Earth and the Solar System

Name: _____ Class: _____ Date: _____ **Total: 18 marks**

0 Vocabulary

Word	Example
rotate /rəʊˈteɪt/ 自转	The Earth takes 24 hours to **rotate** once. 地球**自转**一周需要 24 小时。
axis /ˈæksɪs/ 轴	The Earth spins on its **axis** once a day. 地球绕着它的**轴**每天转一周。
tilted /ˈtɪltɪd/ 倾斜	The Earth's axis is **tilted**, which gives us seasons. 地轴是**倾斜**的，这使我们有了四季。
Sun /sʌn/ 太阳	The **Sun** is a star. **太阳**是一颗恒星。
orbit /ˈɔːbɪt/ 轨道	The Moon's **orbit** takes about 27 days. 月球沿**轨道**运行一周约需 27 天。
seasons /ˈsiːznz/ 季节	The **seasons** are caused by the Earth's tilt. **季节**是由地球倾斜造成的。
Moon /muːn/ 月球	The **Moon** goes round the Earth about once a month. **月球**大约每月绕地球一周。
phases /ˈfeɪzɪz/ 月相	The Moon's **phases** change from new moon to full moon. 月球的**月相**从新月逐渐变为满月。
circumference /sɜːˈkʌmfrəns/ 周长	The **circumference** of the wheel is 2 m. 轮子的**周长**是 2 m。
orbital speed /ˈɔːbɪtl spiːd/ 轨道速率	A planet's **orbital speed** is higher when it is closer to the Sun. 行星越靠近太阳，其**轨道速率**越大。
period /ˈpɪərɪəd/ 周期	The **period** of the wave is 0.02 s. 这个波的**周期**是 0.02 s。
Solar System /ˈsəʊlə ˈsɪstəm/ 太阳系	The **Solar System** has eight planets. **太阳系**有八颗行星。

Word	Example
planet /ˈplænɪt/ 行星	Earth is a **planet** that orbits the Sun. 地球是一颗绕太阳运行的**行星**。
rocky /ˈrɒki/ 岩石	Mars is a **rocky** planet. 火星是一颗**岩石**行星。
gaseous /ˈgeɪsɪəs/ 气态	Jupiter is a **gaseous** planet with no solid surface. 木星是一颗没有固体表面的**气态**行星。
gas /gæs/ 气体	In a **gas**, the particles are far apart and move quickly. 在**气体**中，粒子相距较远，运动迅速。
gas giant /gæs ˈdʒaɪənt/ 气态巨行星	Jupiter is a **gas giant**. 木星是一颗**气态巨行星**。
ice giant /aɪs ˈdʒaɪənt/ 冰巨行星	Neptune is an **ice giant**. 海王星是一颗**冰巨行星**。
dwarf planet /dwɔːf ˈplænɪt/ 矮行星	Pluto is a **dwarf planet**. 冥王星是一颗**矮行星**。
asteroid /ˈæstərɔɪd/ 小行星	An **asteroid** is a small rock that orbits the Sun. **小行星**是一块绕太阳运行的小岩石。
satellite /ˈsætəlaɪt/ 卫星	The **satellite** goes round the Earth. **卫星**绕地球运行。
comet /ˈkɒmɪt/ 彗星	A **comet** has a bright tail near the Sun. **彗星**在靠近太阳时有一条明亮的尾巴。
gravity /ˈgrævɪti/ 引力	**Gravity** keeps the Moon in orbit. **引力**使月球保持在轨道上。
gravitational field strength 重力场强度 /ˌgrævɪˈteɪʃənl fiːld streŋθ/	The **gravitational field strength** on Earth is 9.81 N/kg. 地球上的**重力场强度**为 9.81 N/kg。
ellipse /ɪˈlɪps/ 椭圆	This **ellipse** is wider than it is tall. 这个**椭圆**的宽度大于高度。
conservation of energy 能量守恒 /ˌkɒnsəˈveɪʃn ɒv ˈenədʒi/	**Conservation of energy** means energy is never made or destroyed. **能量守恒**是指能量不会被创造或消灭。
energy /ˈenədʒi/ 能量	Food gives your body the **energy** it needs to move. 食物为你的身体提供运动所需的**能量**。
gravitational potential energy 重力势能 /ˌgrævɪˈteɪʃənl pəˈtenʃl ˈenədʒi/	A book on a high shelf has more **gravitational potential energy**. 高架子上的书具有更多的**重力势能**。

Word	Example
kinetic energy 动能 /kɪˈnetɪk ˈenədʒi/	A fast car has a lot of **kinetic energy**. 一辆快速行驶的汽车具有很大的**动能**。
accretion /əˈkreʃn/ 吸积	**Accretion** builds planets as small pieces join together. 小块物质通过**吸积**聚集在一起，形成行星。
accretion disc /əˈkreʃn dɪsk/ 吸积盘	The young Sun was surrounded by an **accretion disc**. 年轻的太阳周围有一个**吸积盘**。
ultraviolet /ˌʊltrəˈvaɪəlɪt/ 紫外线	**Ultraviolet** light from the Sun can burn your skin. 太阳发出的**紫外线**会灼伤皮肤。

1 Key knowledge and worked examples

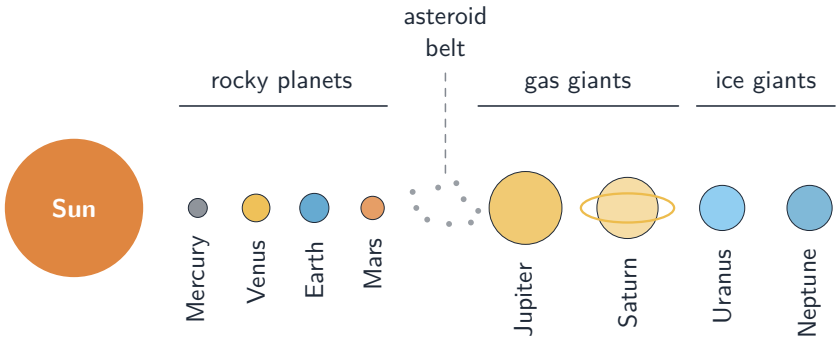
Study these first. Each one shows the method for a question type used later: follow the steps and you can do the Practice and Exam-style questions yourself.

■ The Earth, the Moon and the Sun

motion	time	what it causes
Earth spins on its axis	about 24 hours	day and night
Moon orbits the Earth	about one month	the phases of the Moon (we see different amounts of its sunlit half)
Earth orbits the Sun	about 365 days	the year; with the tilted axis, the seasons

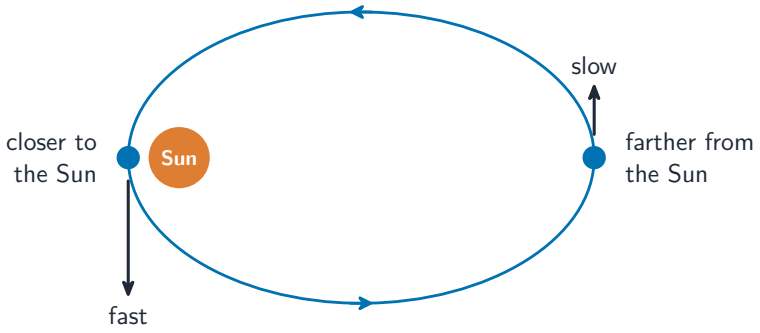
Seasons: the Earth's axis is tilted. The hemisphere tilted towards the Sun gets more direct sunlight for longer each day: summer.

The Solar System



Four small rocky planets, then the asteroid belt, then four large gaseous planets

- Order from the Sun: Mercury, Venus, Earth, Mars (rocky); Jupiter, Saturn, Uranus, Neptune (gas giants).
- **Gravity** keeps planets, moons and comets in orbit. The Sun's gravitational field gets weaker further away, so outer planets move more slowly and take longer to orbit.
- Planets' orbits are almost circular **ellipses** with the Sun at one focus.



An object speeds up when closer to the Sun (PE→KE) and slows down when farther away

A comet in a stretched ellipse is **fastest closest to the Sun**: falling inwards, it turns gravitational potential energy into kinetic energy.

Worked example: orbital speed in km/s

Mars takes 690 Earth days to orbit the Sun at an average radius of 2.28×10^8 km. Find its orbital speed in km/s.

1. Orbital speed is the circumference over the period: $v = \dfrac{2\pi r}{T}$.
2. Period in seconds: $T = 690 \times 24 \times 3600 \text{ s} = 5.96 \times 10^7 \text{ s}$.
3. $$v = \frac{2\pi r}{T} = \frac{2\pi(2.28 \times 10^8 \text{ km})}{5.96 \times 10^7 \text{ s}} = \mathbf{24} \text{ km/s}$$

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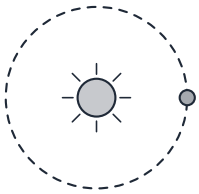
Keep r in km to get km/s; use T in hours to get km/h.

2 Practice

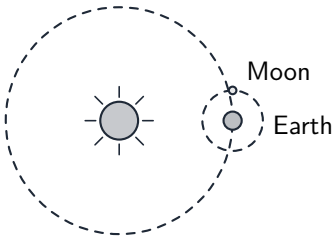
2.1 State what causes day and night. [1]

day and night

2.2 Name the force that keeps a planet in orbit around the Sun. [1]



2.3 State the approximate time taken for one orbit of the Earth around the Sun, and of the Moon around the Earth. [2]



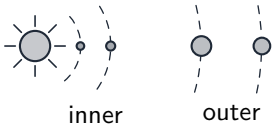
2.4 Explain why the Earth has seasons. [2]

seasons

3 Exam-style questions

3.1 Compared with the inner planets, the outer planets orbit the Sun: [1]

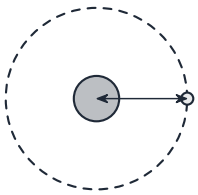
☐ **A** faster
B more slowly
C at the same speed
D in the opposite direction



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3.2 A moon orbits a planet at a radius of 4.0×10^8 m with a period of 2.0×10^6 s.

(a) Find its orbital speed. [3]

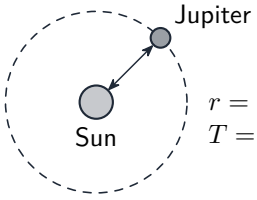


(b) State what happens to the gravitational field strength of the planet as you move further from it. [1]

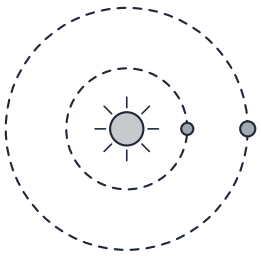
3.3 A comet moves in a very stretched elliptical orbit. Explain why it moves fastest when closest to the Sun. [2]



3.4 Jupiter takes 4330 Earth days to orbit the Sun. Its average orbital radius is 7.8×10^8 km. An Earth day is 24 h. Calculate the average orbital speed of Jupiter in km/s. [3]



3.5 The strength of the Sun's gravitational field decreases with distance from the Sun. Explain why planets further from the Sun have a lower orbital speed and a longer orbital period. [2]



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Solutions

Each answer shows the steps, then the **result**.

2.1

- the Earth spinning (rotating) on its axis

2.2

- gravity / the Sun's gravitational attraction

2.3

- the Earth takes about 365 days (one year) to orbit the Sun
- the Moon takes about one month (about 27 days) to orbit the Earth

2.4

- the Earth's axis is tilted
- as the Earth orbits the Sun, each hemisphere is tilted towards the Sun for part of the year, receiving more direct sunlight for longer each day: summer

3.1 B

- the Sun's gravity is weaker further out, so outer planets move more slowly

3.2

(a) $v = 2\pi r/T$

$$v = \frac{2\pi(4.0 \times 10^8 \text{ m})}{2.0 \times 10^6 \text{ s}} = \mathbf{1.3 \times 10^3} \ \frac{\text{m}}{\text{s}}$$

(b) it decreases (gets weaker)

3.3

- as the comet comes closer, its gravitational potential energy falls
- by conservation of energy this becomes kinetic energy, so it speeds up

3.4

- period in seconds: $T = 4330 \times 24 \times 3600 \text{ s} = 3.74 \times 10^8 \text{ s}$
- orbital speed $v = \dfrac{2\pi r}{T}$

$$v = \frac{2\pi r}{T} = \frac{2\pi(7.8 \times 10^8 \text{ km})}{3.74 \times 10^8 \text{ s}} = \mathbf{13} \text{ km/s}$$

3.5

- the Sun's gravitational force on a distant planet is weaker, so a lower speed is enough to keep it in orbit
- it also travels a longer path ($2\pi r$ is larger) at a lower speed, so each orbit takes longer

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