CAMBRIDGE IGCSE™ PHYSICS 0625 | TOPIC 6

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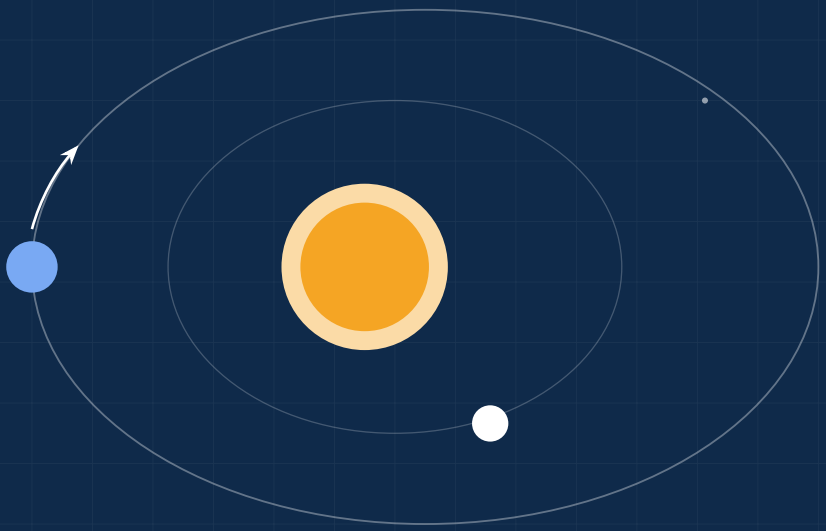
# Space Physics

Free sample: knowledge organiser and Worksheet 1 with answers

Earth & Moon | Seasons | The Solar System | Orbital speed | Life cycle of stars | Redshift & Big Bang | Exam-style questions

$$v = 2\pi r / T$$

$$H_0 = v / d$$



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Full pack: worksheets, exam paper, answers

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# Knowledge organiser



## The Earth and the Moon

The Earth **spins** on its tilted axis about once every **24 hours**: day and night, and the Sun's apparent movement across the sky.

The Earth **orbits** the Sun about once every **365 days**. Its axis is **tilted**, so we have **seasons**.

The Moon orbits the Earth about once a **month**. We see different amounts of its sunlit half: the **phases**.

SUPPLEMENT Average orbital speed: $v = \frac{2\pi r}{T}$ ($r$ = average orbital radius, $T$ = orbital period)

## The Solar System

One star (the Sun), **eight planets**, minor planets (dwarf planets such as Pluto, and asteroids), moons, and smaller bodies such as comets.

**Mercury, Venus, Earth, Mars** (small, rocky) | **Jupiter, Saturn, Uranus, Neptune** (large, gaseous)

**Accretion model:** a rotating cloud of gas and dust collapses under **gravity** into an **accretion disc**; the Sun forms at the centre and the planets form in the disc.

## Gravity and orbits

The Sun has most of the mass of the Solar System. Its **gravitational attraction** keeps the planets in orbit.

$g$ at a planet's surface depends on the planet's **mass**; $g$ gets **smaller** further from the planet.

Light travel time: $t = \frac{d}{c}$, $c = 3.0 \times 10^8$ m/s

SUPPLEMENT Orbits are **elliptical**; the Sun is not at the centre (except when the orbit is nearly circular). Further from the Sun: weaker field, **lower orbital speed**. In an elliptical orbit a planet or comet moves **fastest when closest** to the Sun (GPE → KE).

## The Sun and other stars

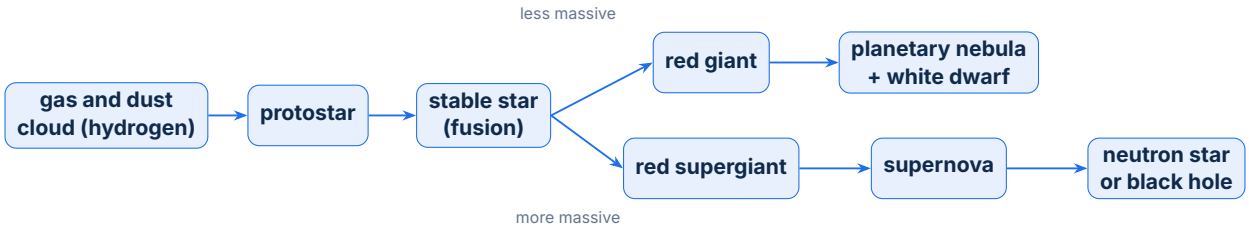
The Sun is a **medium-sized star**, mainly **hydrogen and helium**. It radiates mostly **infrared, visible light and ultraviolet**.

SUPPLEMENT Stars are powered by **nuclear fusion**: hydrogen nuclei fuse to make helium.

A **galaxy** has many billions of stars. The Sun is in the **Milky Way**; other stars are much further away than the Sun.

**Light-year:** the distance light travels in a vacuum in one year. SUPPLEMENT $1\,\text{ly} = 9.5 \times 10^{15}$ m

## SUPPLEMENT Life cycle of a star




The nebula left by a supernova contains hydrogen and heavier elements; it may form new stars with planets.

## The Universe

The Milky Way is one of **many billions** of galaxies; its diameter is about **100 000 light-years**.

**Redshift:** the observed wavelength of light from a receding galaxy is **longer** than when emitted. Light from distant galaxies is redshifted, so the **Universe is expanding**: evidence for the **Big Bang**.

SUPPLEMENT **CMBR:** microwave radiation from all directions, produced shortly after the Universe formed and stretched to microwave wavelengths by the expansion.

SUPPLEMENT $v$ from redshift, $d$ from a supernova's brightness. $H_0 = \frac{v}{d} \approx 2.2 \times 10^{-18}\ \text{s}^{-1}$

SUPPLEMENT Age of the Universe $\approx \frac{d}{v} = \frac{1}{H_0}$

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# The Earth and the Moon

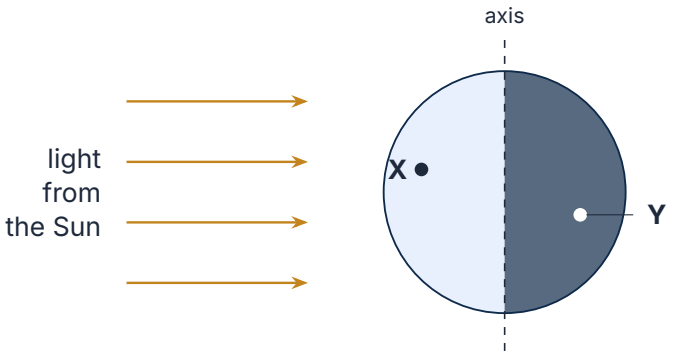
WORKSHEET 1

CORE SUPPLEMENT

**You will:** explain day and night, the Sun's apparent daily movement, the seasons and the phases of the Moon, and (Extended) calculate average orbital speeds using $v = 2\pi r/T$.

CORE all students SUPPLEMENT Extended (Supplement) students CHALLENGE stretch question

**1** CORE The diagram shows the Earth lit by the Sun. It is not to scale.




**(a)** State how long it takes the Earth to rotate once on its axis. [1]

.....

**(b)** Explain why it is daytime at X and night-time at Y. [2]

.....

.....

**(c)** Each day the Sun appears to rise in the east, move across the sky and set in the west. Explain why. [2]

.....

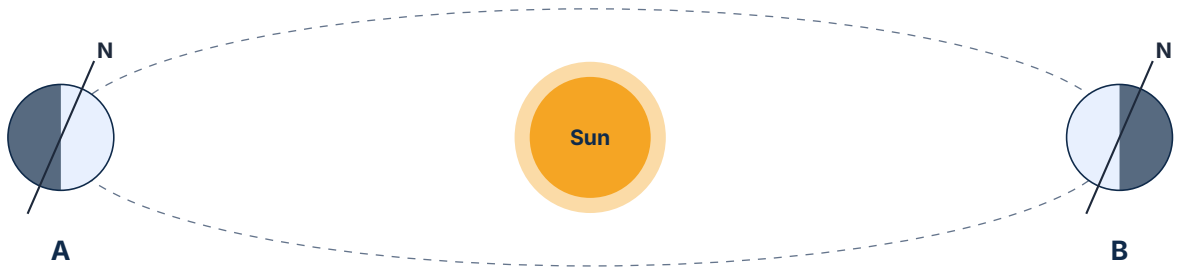
.....

**2** CORE Complete the table. [3]

| Motion | Approximate time taken |
|---|---|
| the Earth rotates once on its axis | |
| the Earth orbits the Sun once | |
| the Moon orbits the Earth once | |

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**3** CORE The diagram shows the Earth at two positions, A and B, in its orbit around the Sun. The Earth's axis is tilted. N is the North Pole. The orbit is almost circular; it is drawn in perspective. The diagram is not to scale.




**(a)** State the position, A or B, at which it is summer in the northern hemisphere. [1]

.....

**(b)** Explain why the northern hemisphere is warmer at this position. [2]

.....

.....

**(c)** A student says: "It is summer when the Earth is closest to the Sun." Use the diagram to explain why the student is wrong. [2]

.....

.....

**4** CORE Write **T** (true) or **F** (false) next to each statement. [4]

The Earth orbits the Sun once every 24 hours. _____

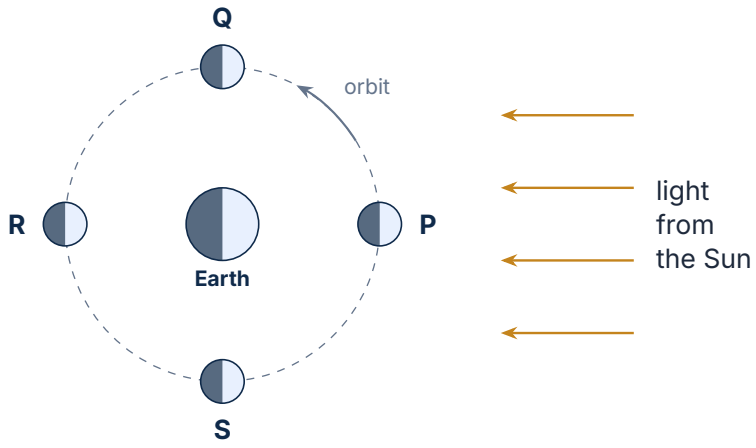
The Earth's tilted axis is the reason for the seasons. _____

The Moon is lit by light from the Sun. _____

It is summer in both hemispheres at the same time. _____

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**5** CORE The diagram shows the Moon at four positions, P, Q, R and S, in its orbit around the Earth, seen from above the North Pole. Sunlight comes from the right. The diagram is not to scale.




**(a)** State the position at which an observer on the Earth sees a full moon. [1]

.....

**(b)** State the position at which an observer on the Earth sees a new moon (no lit part visible). [1]

.....

**(c)** The Moon does not give out its own light. Explain why the Moon seems to change shape during one month. [2]

.....

.....

**6** SUPPLEMENT The Earth orbits the Sun at an average orbital radius of $1.5 \times 10^{11}$ m. The orbital period is 365 days.

**(a)** Show that the orbital period is about $3.2 \times 10^{7}$ s. [1]

.....

**(b)** Calculate the average orbital speed of the Earth. [2]

.....

speed = _____

**7** SUPPLEMENT The Moon orbits the Earth at an average orbital radius of $3.84 \times 10^{8}$ m. Its orbital period is 27.3 days. Calculate the average orbital speed of the Moon in m/s. [3]

.....

.....

speed = _____

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**8** SUPPLEMENT CHALLENGE A communications satellite orbits above the Equator once every 24 hours, in the same direction as the Earth rotates. Its average orbital speed is $3.07 \times 10^3$ m/s.

**(a)** Calculate the average orbital radius of the satellite. [3]

radius = _____

**(b)** Explain why a dish aerial on the ground can stay pointed at this satellite without moving. [2]

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# Answers: Worksheet 1



Mark codes: B1 independent mark C1 method mark, implied by a correct final answer A1 correct answer with unit. Accept answers that round correctly; allow error carried forward from earlier parts.

## Worksheet 1 – The Earth and the Moon

**1** **(a)** About **24 hours** B1
**(b)** X is on the half of the Earth facing the Sun, so it receives sunlight B1; Y is on the half facing away from the Sun, so it is in shadow B1
**(c)** The Earth rotates (spins) on its axis B1; from west to east, so the Sun appears to move from east to west across the sky B1

**2** About **24 hours** B1; about **365 days** (one year) B1; about **one month** (accept 27–30 days) B1

**3** **(a)** **A** B1
**(b)** The northern hemisphere is tilted towards the Sun B1; the Sun is higher in the sky, so the sunlight is more concentrated on each square metre (and the days are longer) B1
**(c)** The diagram shows the Earth at (about) the same distance from the Sun at A and at B B1; the seasons are caused by the tilt of the axis: when it is summer in one hemisphere it is winter in the other, which could not happen if distance were the cause B1

**4** F B1; T B1; T B1; F B1

**5** **(a)** **R** B1
**(b)** **P** B1
**(c)** The Moon reflects light from the Sun; one half of it is always lit B1; as the Moon orbits the Earth we see different amounts of the lit half B1

**6** **(a)** $365 \times 24 \times 3600 = 3.15 \times 10^7$ s ($\approx 3.2 \times 10^7$ s) B1
**(b)** $v = 2\pi r/T = 2\pi \times 1.5 \times 10^{11} \div 3.15 \times 10^7$ C1 $=$ **$3.0 \times 10^4$ m/s** (30 km/s) A1

**7** $T = 27.3 \times 24 \times 3600 = 2.36 \times 10^6$ s C1
$v = 2\pi \times 3.84 \times 10^8 \div 2.36 \times 10^6$ C1
$=$ **$1.0 \times 10^3$ m/s** A1

**8** **(a)** $T = 24 \times 3600 = 86\,400$ s C1; $r = vT/2\pi = 3.07 \times 10^3 \times 86400 \div 2\pi$ C1
$=$ **$4.2 \times 10^7$ m** A1 (about $3.6 \times 10^7$ m above the Earth's surface)
**(b)** The satellite takes the same time to go round once (24 hours) as the Earth takes to rotate once, in the same direction B1; so it stays above the same point on the Equator and the aerial always points the same way B1

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# Get the full pack



**You have just used Worksheet 1. The full Space Physics pack contains:**

- **Worksheet 1:** The Earth and the Moon
- **Worksheet 2:** The Solar System
- **Worksheet 3:** The Sun and the stars
- **Worksheet 4:** The Universe
- **Multiple-choice practice:** 10 Paper 1/2-style questions
- **Practical skills:** an Alternative to Practical (Paper 6) question
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