Physics - Key Stage 4

Space

Orbits

Students’ downloadable resources

Mr C White

Question slides from video

Let’s construct a summary table. Copy and complete the table below.

Feature	A star	A planet	A moon	Artificial Satellite
Orbit	Around the centre of its home galaxy			Around a larger body (around _____ in the case of, e.g. weather and communication)
Relative mass	Very large	Large	Small	
Origin	Natural (from a _____)	_____ (from old star material)	Natural (from old star material)	
Produces its own light?	_____ – through fusion reactions	_____ – reflects star light		No – reflects star light

Non-circular orbits

When the bodies are further apart (e.g. moon and planet) the force between them (due to _____) increases/decreases/remains constant.

When the bodies are further apart, the speed at which the orbiting body must go to maintain a stable orbit increases/decreases/remains constant.

Quick maths practice:

- Using formulae (including the circumference of a circle)
- Using standard form

You will need your calculator.

QUICK MATHS PRACTICE

Calculate the speed of the Earth around the Sun. Use the appropriate equations and the data below.

Earth-Sun distance = 1.5×10^{11}m

Earth's orbital period = 3.2×10^{7}s

Express your answer in standard form to 2 significant figures.

EXAM STYLE QUESTIONS

Look at the data for the solar system in the table.

Write down what is meant by:

(a) orbital period (1 mark)

(b) velocity (1 mark)

Give the following data in standard form to 2 significant figures:

(c) the orbital radius of Earth in metres (2 marks)

(d) the orbital period of Jupiter in days (1 mark).

Body	Orbital radius ($x10^6$ km)	Orbital period (days)
Mercury	58	88
Venus	108	225
Earth	150	365
Mars	228	687
Ceres	414	1680
Jupiter	778	4331
Saturn	1430	10750

EXAM STYLE QUESTIONS

Look at the data for the solar system in the table.

(e) Write down the relationship between the orbital radius of the bodies in the solar system and their orbital period. (1 mark)

(f) From the data in the table, identify the planet whose average speed around the Sun is the least. Explain your answer. (3 marks)

MOVE TO THE NEXT SLIDE WHEN READY

Body	Orbital radius ($x10^6$ km)	Orbital period (days)
Mercury	58	88
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EXAM STYLE QUESTIONS

(g) A student claimed that she could calculate the orbital period, P, in days for any planet if she knew its orbital radius, R in millions of km. Her formula was:

$$P = 0.2 \times R \times \sqrt{R}$$

Calculate the orbital periods for Mercury and Mars to 2 significant figures using the student's formula and evaluate her claim. (5 marks)

Body	Orbital radius ($x10^6$ km)	Orbital period (days)
Mercury	58	88
Venus	108	225
Earth	150	365
Mars	228	687
Ceres	414	1680
Jupiter	778	4331
Saturn	1430	10750

Answers

SOLUTIONS

Feature	A star	A planet	A moon	Artificial Satellite
Orbit	Around the centre of its home galaxy	**Around its parent star**	**Around a planet**	Around a larger body (around _____ in the case of, e.g. weather and communication)
Relative mass	Very large	Large	Small	**Negligible/very small**
Origin	Natural (from a **nebula**)	**Natural** (from old star material)	Natural (from old star material)	**Man-made (synthetic)**
Produces its own light?	**YES** – through fusion reactions	**NO** – reflects star light	**NO – reflects star light**	No – reflects star light

Non-circular orbits - SOLUTIONS

When the bodies are further apart (e.g. moon and planet) the force between them (due to **gravity**) **decreases**.

When the bodies are further apart, the speed at which the orbiting body must go to maintain a stable orbit **decreases**.

QUICK MATHS PRACTICE - SOLUTIONS

Calculate the speed of the Earth around the Sun. Use the appropriate equations and the data below.

Earth-Sun distance = 1.5×10^{11}m

Earth's orbital period = 3.2×10^{7}s

Express your answer in standard form to 2 significant figures.

Values, **E**quation, **S**ubstitute, **R**earrange, **A**nswer, **U**nits

Distance travelled in 1 year = 1 circumference = $2\pi r$

$c = 2 \times \pi \times 1.5 \times 10^{11} = 9.4 \times 10^{11}$m

Speed = distance ÷ time = $9.4 \times 10^{11} \div 3.2 \times 10^{7} = 29452 =$ $\underline{2.9 \times 10^{4}\text{m/s}}$

EXAM STYLE SOLUTIONS

(a) time taken for one complete orbit around the Sun (1 mark)

(b) speed with direction/in a specified direction (1 mark)

(c) 1.5×10^{11} m (1 mark for conversion of km to m, 1 for correct standard form)

(d) 4.3×10^{3} days (1 mark).

Body	Orbital radius ($\times 10^6$ km)	Orbital period (days)
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EXAM STYLE QUESTIONS

(e) as the orbital radius increases, the orbital period increases (*ignore 'directly proportional'*) (1 mark)

(f) Saturn (1 mark) it is the furthest from the Sun (1 mark) so it has the least/weakest/lowest gravitational force acting on it (1 mark)

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EXAM STYLE QUESTIONS

(g) Mercury

$P = 0.2 \times R \times \sqrt{R}$

$P = 0.2 \times 58 \times \sqrt{58} = 88.34$ (1 mark)

= 88 days to 2sf (1 mark)

Mars

$P = 0.2 \times R \times \sqrt{R}$

$P = 0.2 \times 228 \times \sqrt{228} = 688.54$ (1 mark)

= 690 days to 2sf (1 mark)

Formula is correct as both values agree to 2sf (1 mark)

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