GRAVITY

SENT INTO SPACE CLASSTRONAUTS PROGRAMME

LAUNCH YOUR SCHOOL INTO SPACE

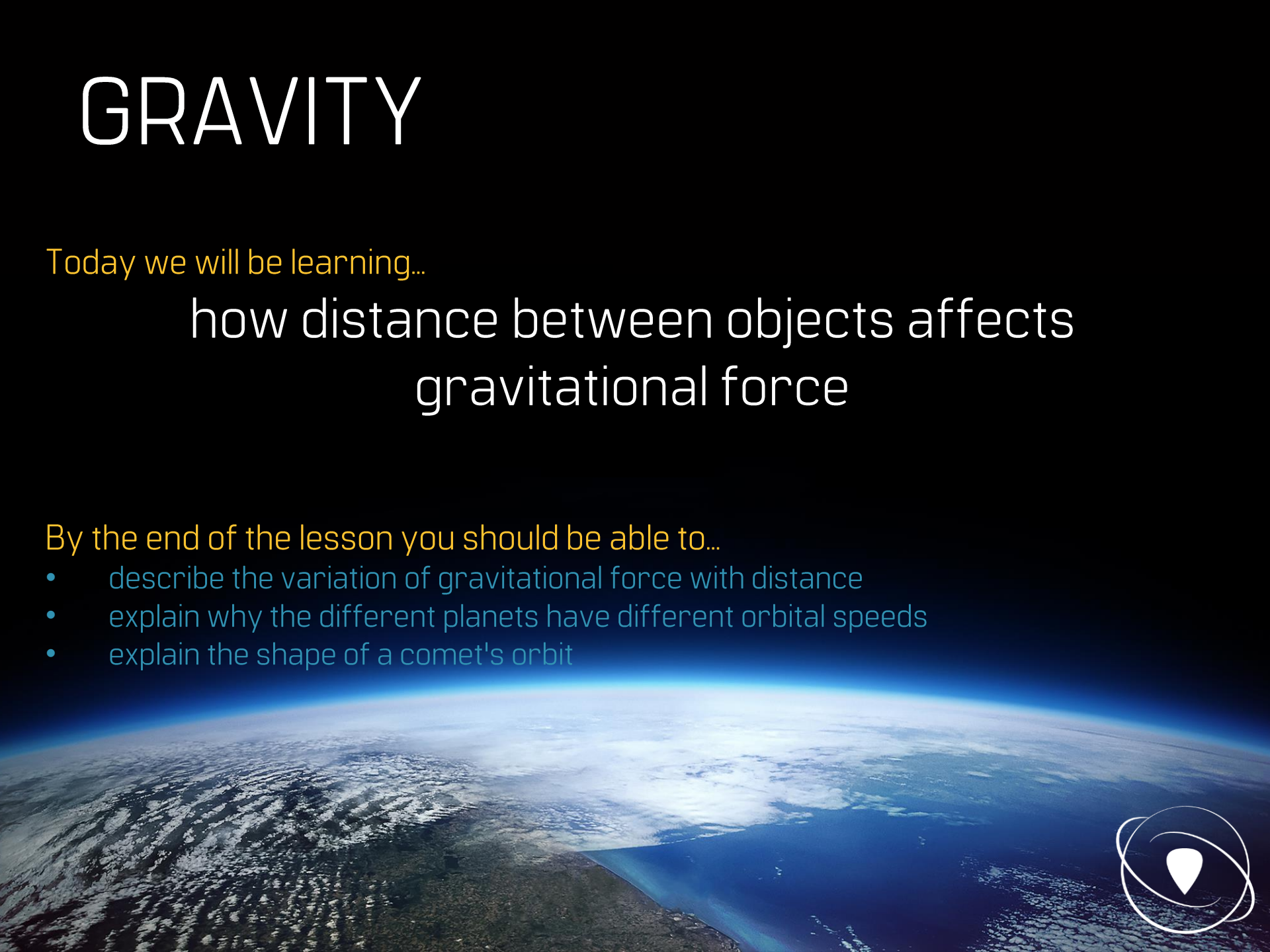
GRAVITY

Today we will be learning...

how distance between objects affects gravitational force

By the end of the lesson you should be able to...

- describe the variation of gravitational force with distance
- explain why the different planets have different orbital speeds
- explain the shape of a comet's orbit



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Question

In terms of Newton's 3rd Law, describe the gravitational force which acts on an object on Earth

Task

Without looking in your books, in pairs or groups, write an answer to the question above on a big sheet of paper.

You will then share your answers, and vote on the best one.

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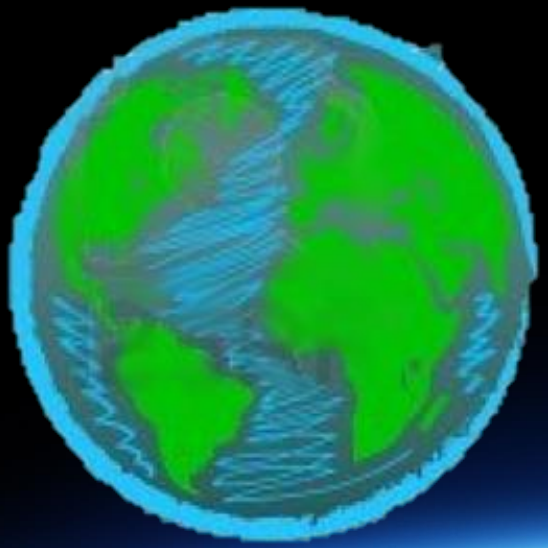
Gravity is a force of attraction between two objects.



Why?

The Earth pulls on an object, and the object pulls on the Earth with an equal and opposite force.

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Imagine you and someone else are billions of miles apart in an otherwise empty universe.

What would happen?

Task

In groups, come up with your own theory for how gravity works.

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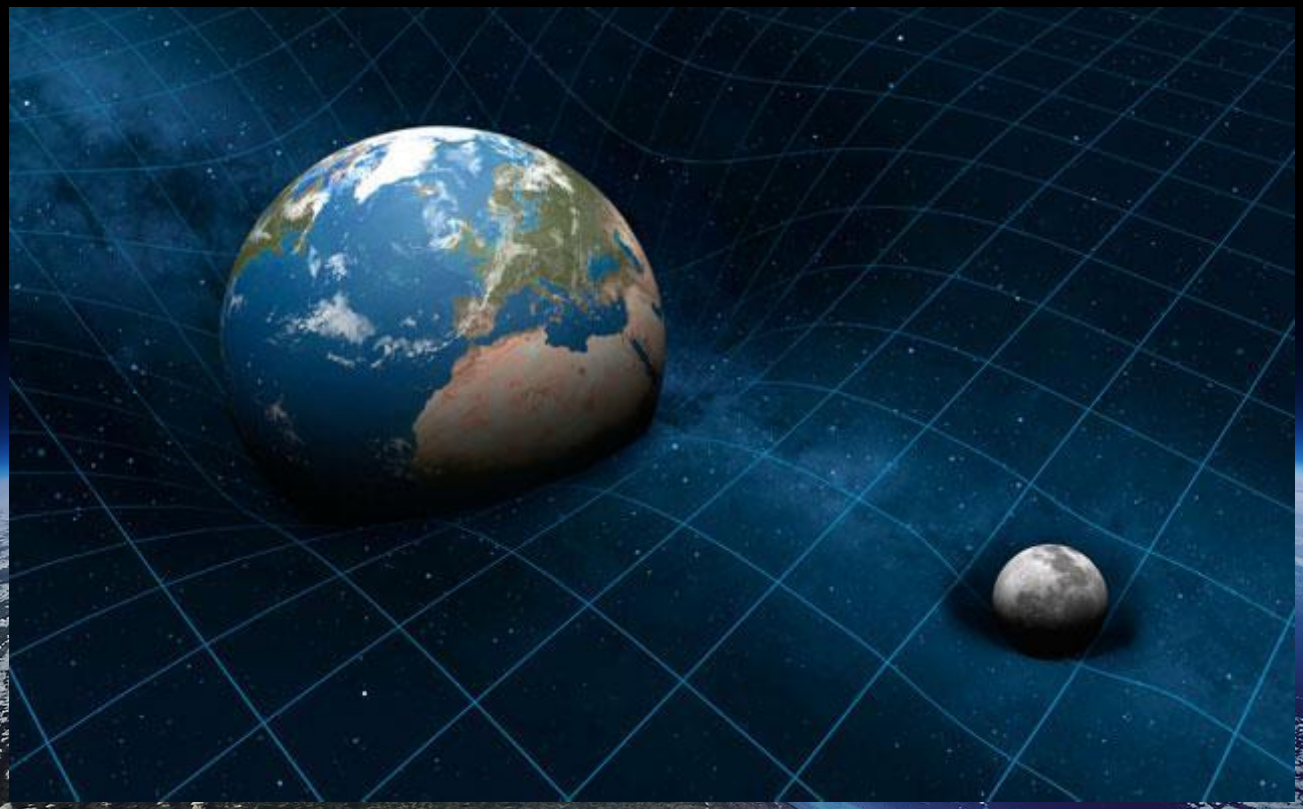
Gravitational Theory - General Relativity

Space is 'curved' by the presence of large objects, which causes other objects to move towards them.



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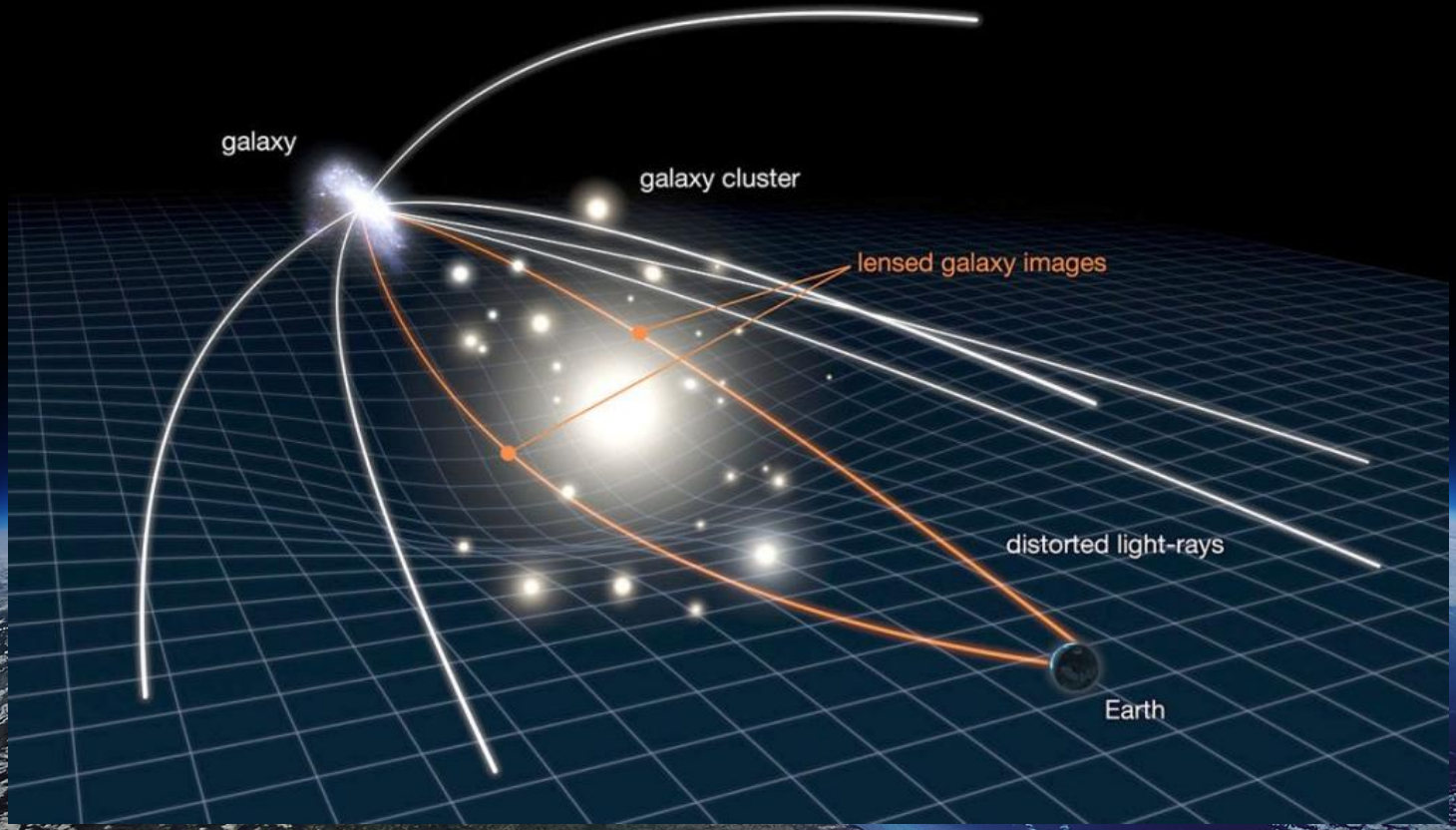
Gravitational Theory - General Relativity

Evidence: Gravitational lensing



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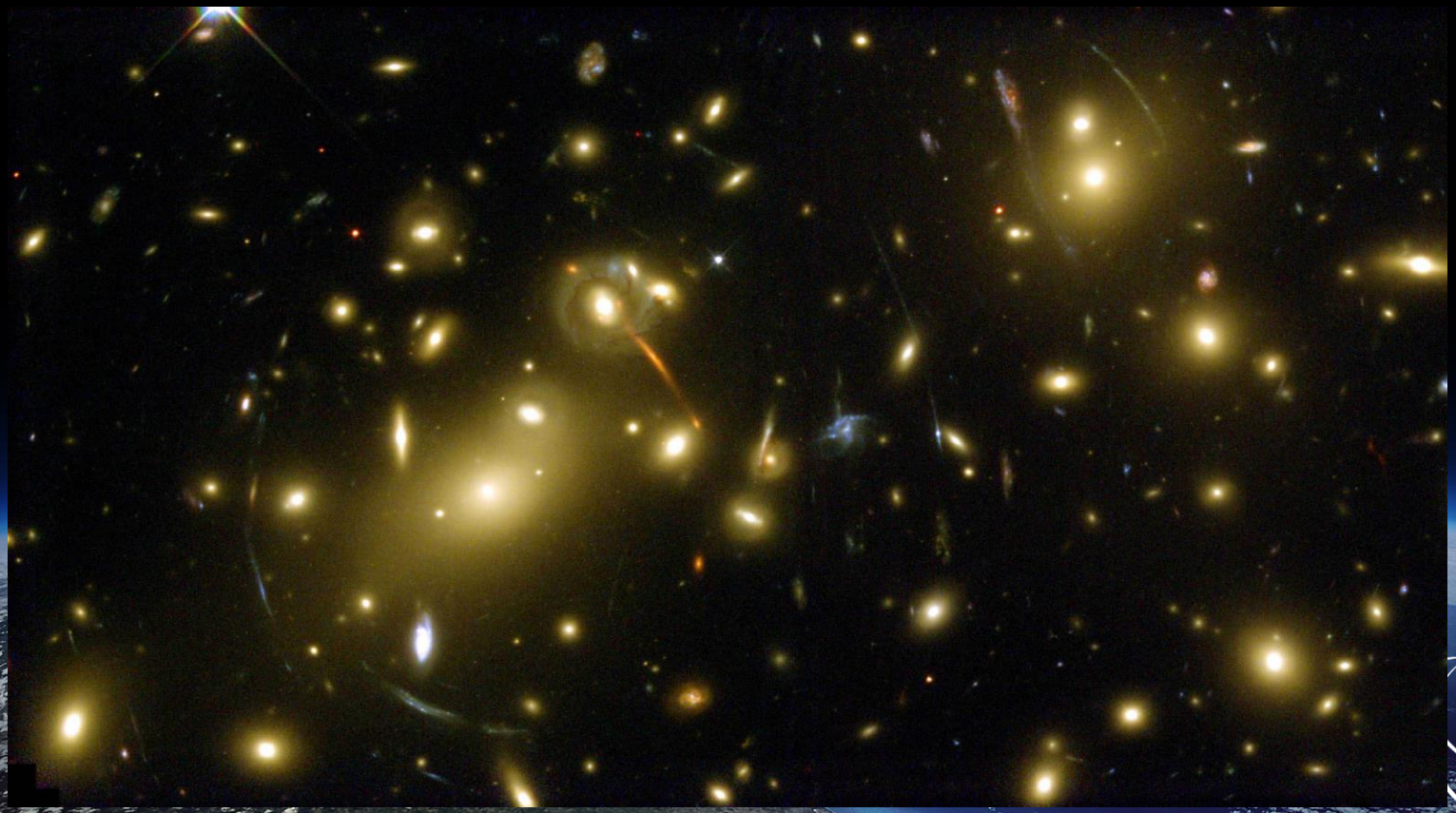

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Which of the statements below do you think is the most correct?

A Gravitational force *increases* the further you get from an object, because the distance between them is greater.

B Gravitational force *decreases* the further you get from an object, because the distance between them is greater.

C Gravitational force *stays the same*, no matter what the distance, because gravitational acceleration ($g=10 m/s^2$) is constant.

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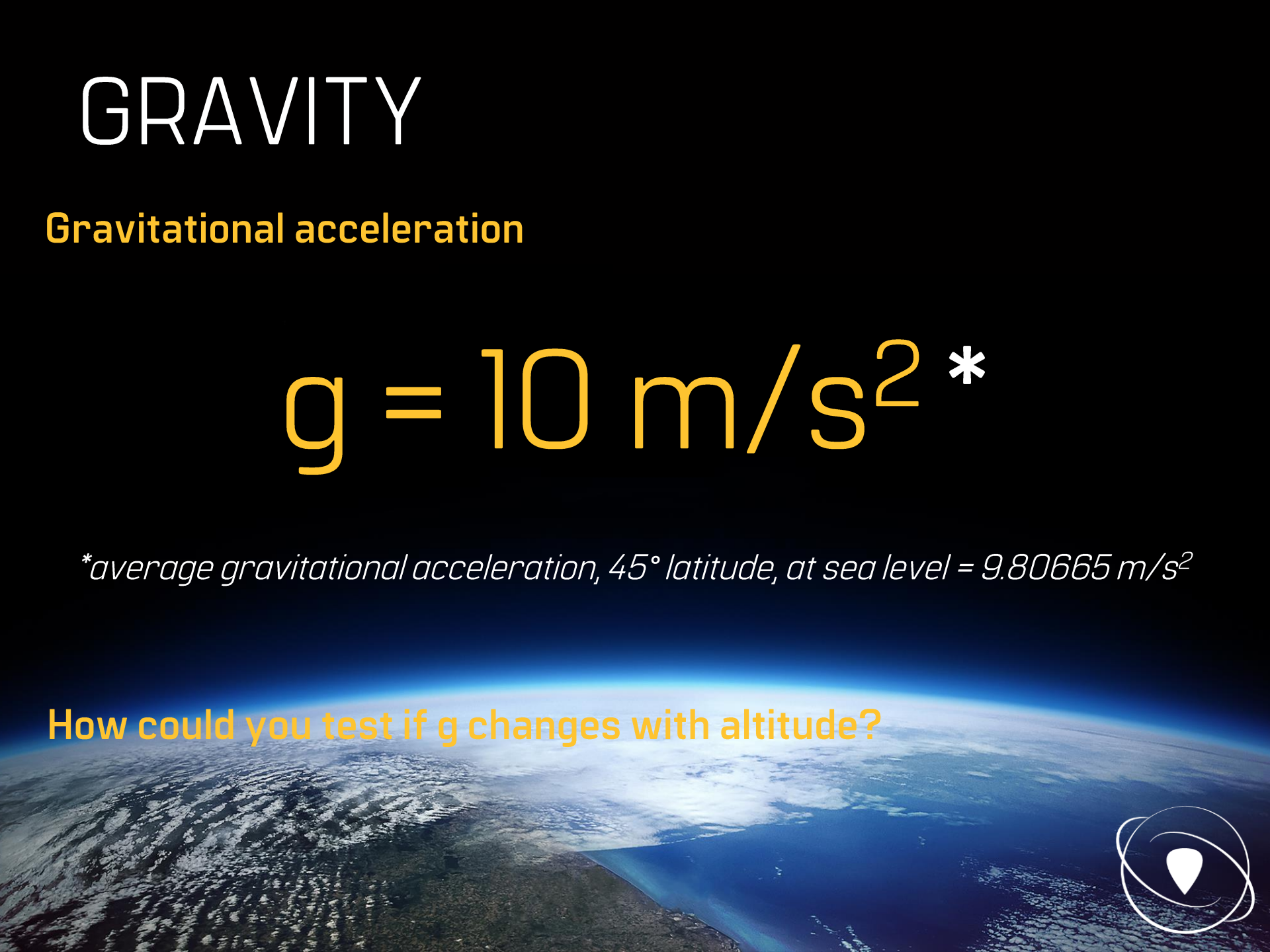
Gravitational acceleration

$$g = 10\ m/s^2\ *$$

**average gravitational acceleration, 45° latitude, at sea level = 9.80665 m/s²*

How could you test if g changes with altitude?



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Testing gravitational acceleration

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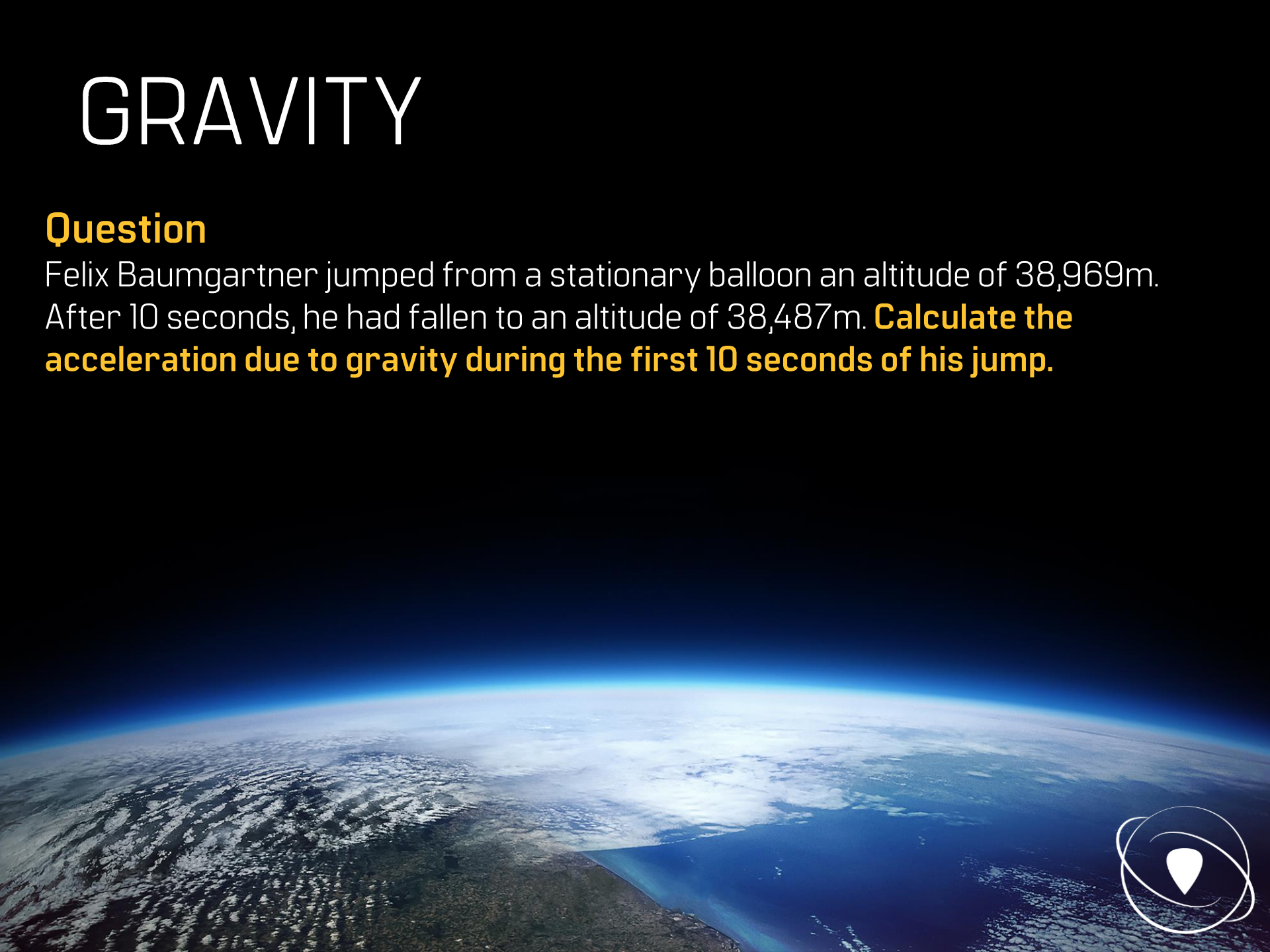
Question

Felix Baumgartner jumped from a stationary balloon an altitude of 38,969m. After 10 seconds, he had fallen to an altitude of 38,487m. **Calculate the acceleration due to gravity during the first 10 seconds of his jump.**



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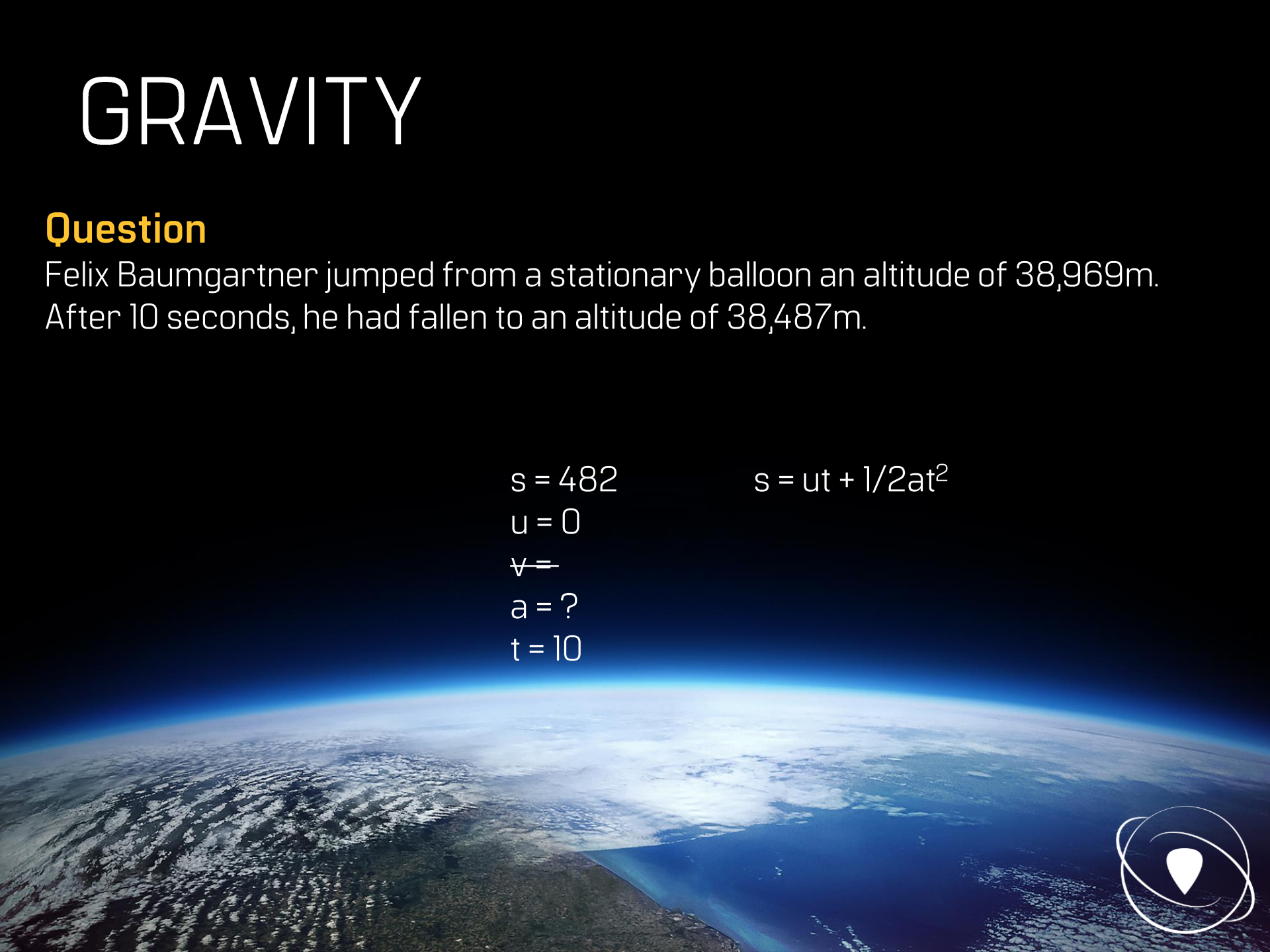
Question

Felix Baumgartner jumped from a stationary balloon an altitude of 38,969m. After 10 seconds, he had fallen to an altitude of 38,487m.

$s = 482$
$u = 0$
~~$v =$~~
$a = ?$
$t = 10$

$s = ut + 1/2at^2$



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Question

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s = 482
u = 0
~~v =~~
a = ?
t = 10

$s = ut + 1/2at^2$
$482 = 0 + 1/2 \times 10^2 \times a$
$482 = 50a$
$a = 482/50$
$a = \underline{\mathbf{9.64\ m/s^2}}$

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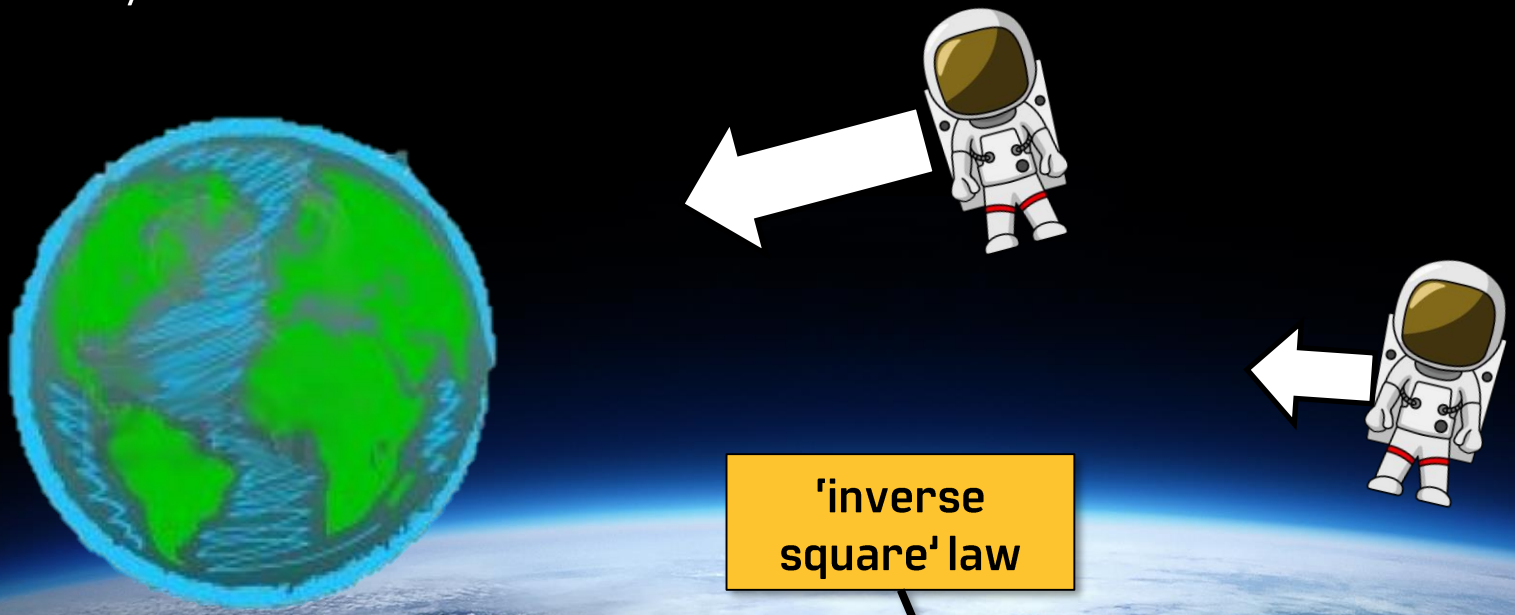
Gravity

The closer you are to an object, the greater the force due to gravity.



'inverse square' law

$$gravitational\ force \propto \frac{1}{distance^2}$$

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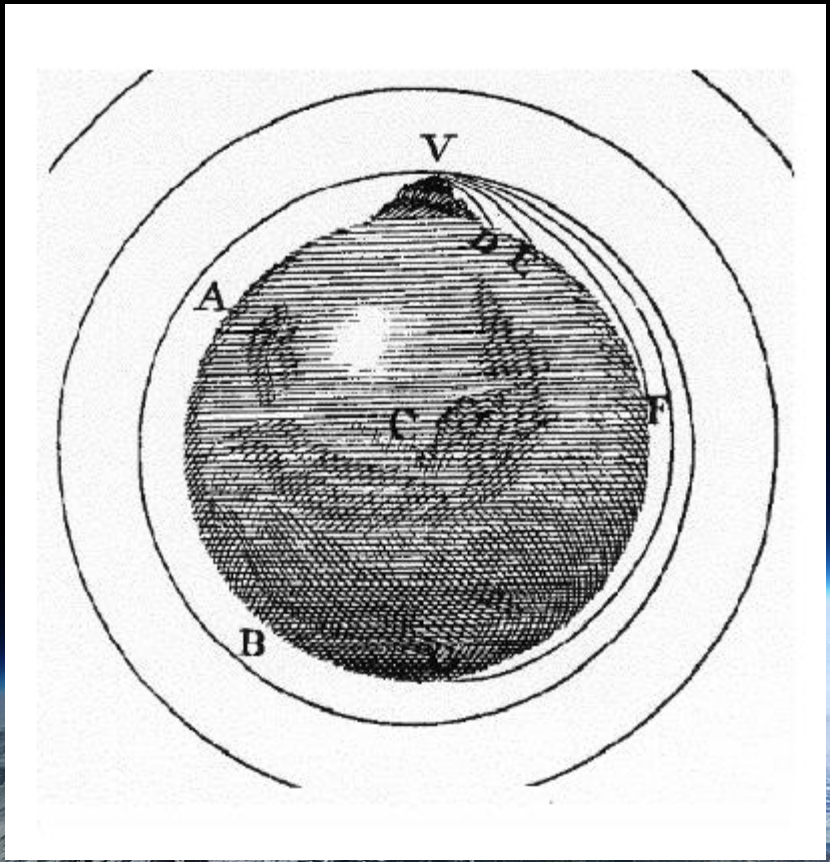
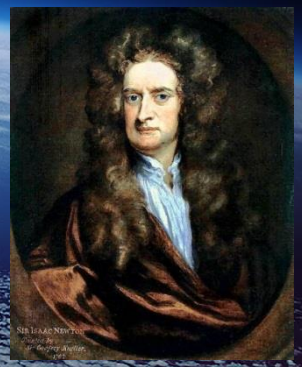
Newton's Cannon



Isaac Newton suggested that an object fired from a very high peak on Earth would never hit the ground if it is launched with enough initial speed.



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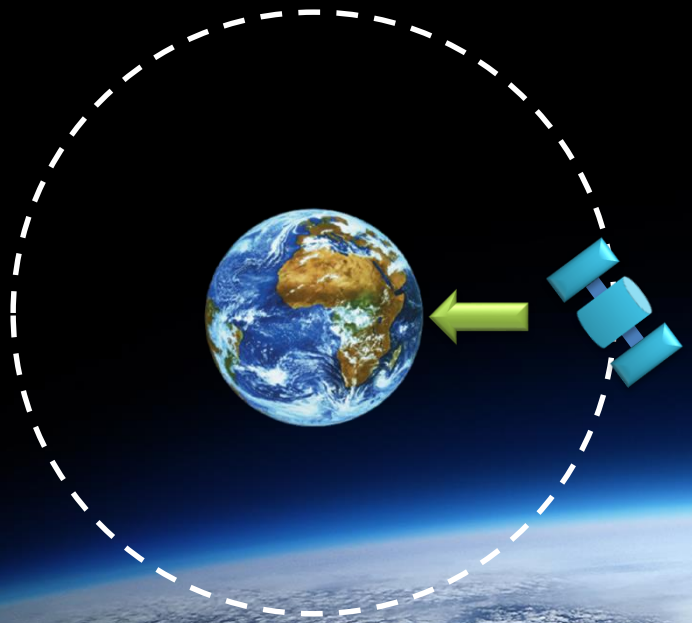
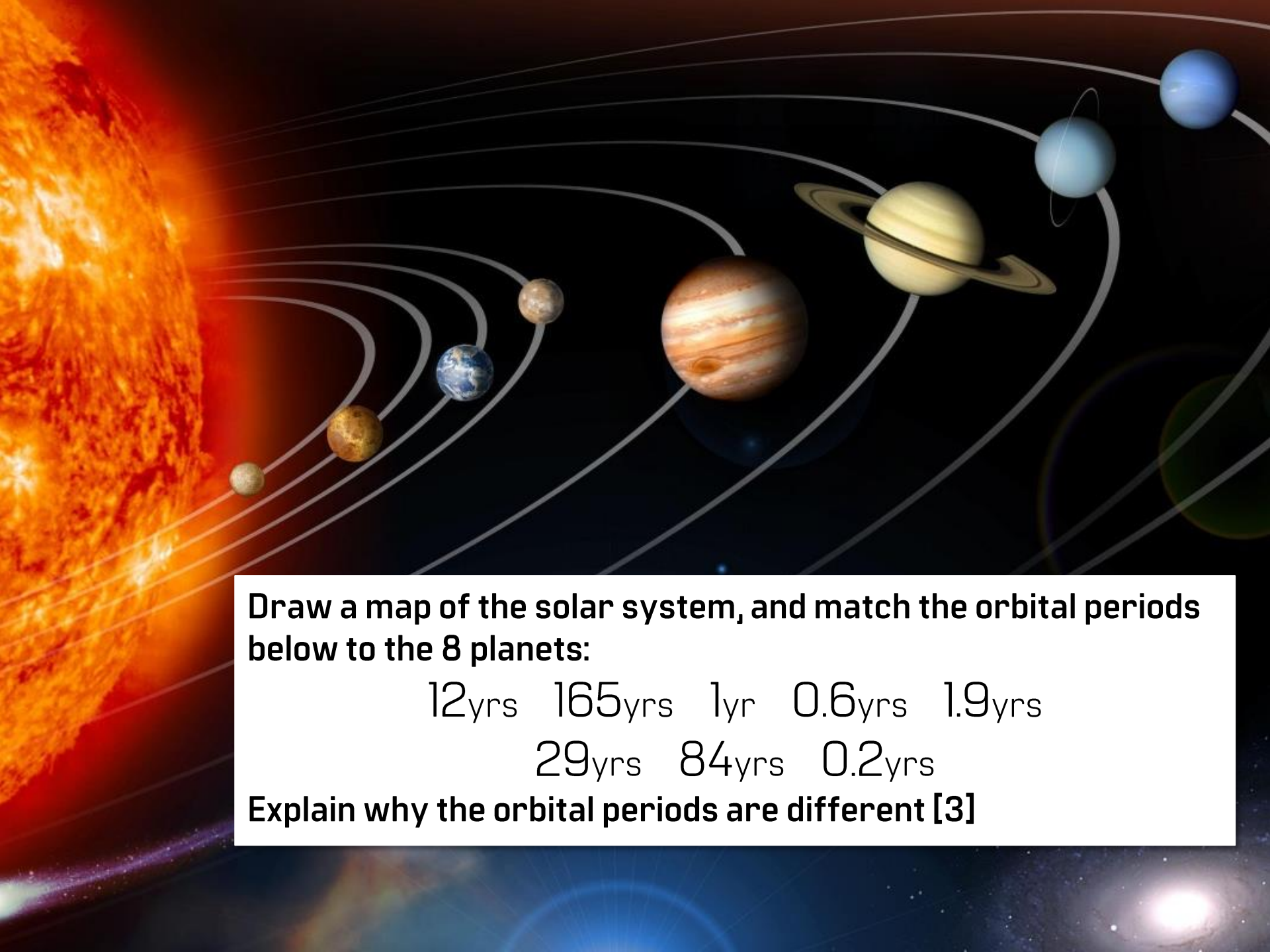
Gravity and Orbits



The resultant force the keeps objects in moving in a circle is a **centripetal force**, in this case provided by **gravity**.

(NOT 'centrifugal' force)

This is just like the tension in string when swinging an object around your head.



Draw a map of the solar system, and match the orbital periods below to the 8 planets:

12yrs 165yrs 1yr 0.6yrs 1.9yrs

29yrs 84yrs 0.2yrs

Explain why the orbital periods are different [3]

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Task

What does the data below show about the gravitational force on different planets? Discuss in groups.

	Distance (AU)	Orbital Period (years)	Orbital speed (km/s)
Mercury	0.4	0.24	48
Venus	0.7	0.61	35
Earth	1.0	1.0	30
Mars	1.5	1.9	24
Jupiter	5.2	12	13
Saturn	9.5	29	9.6
Uranus	19	84	6.8
Neptune	30	165	5.4

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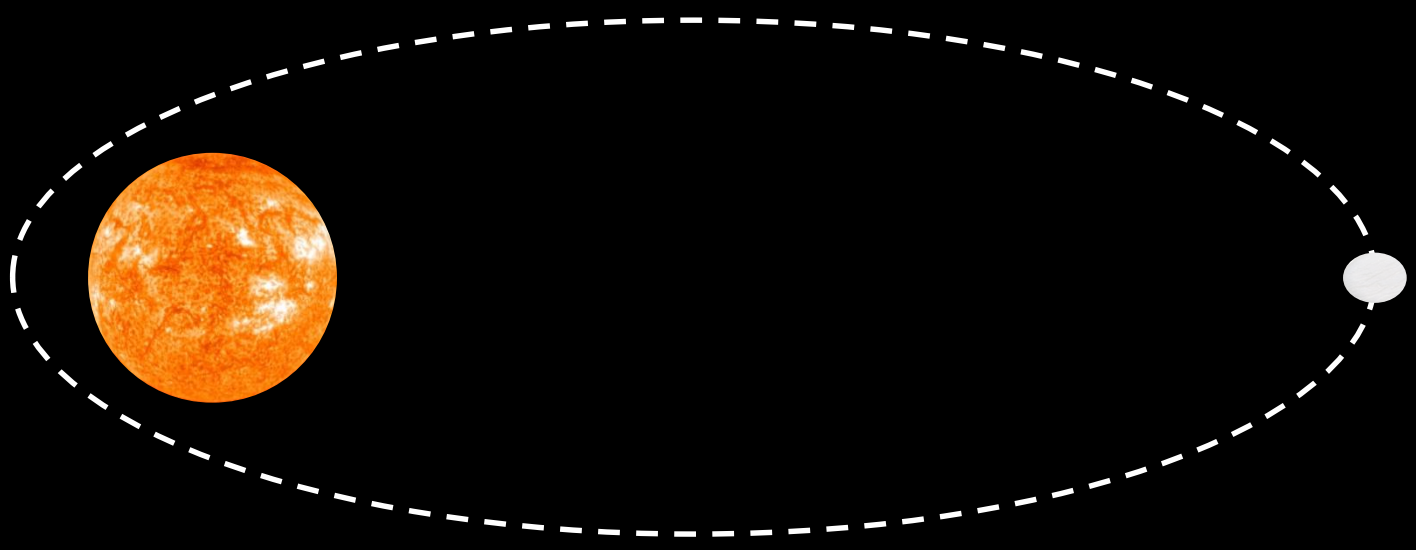
Comets

Comets have very **elliptical** orbits.



As they get closer to the sun, **write what you think would happen to;**

(a) The force on the comet

(b) The speed of the comet

Make sure you explain your reasons why

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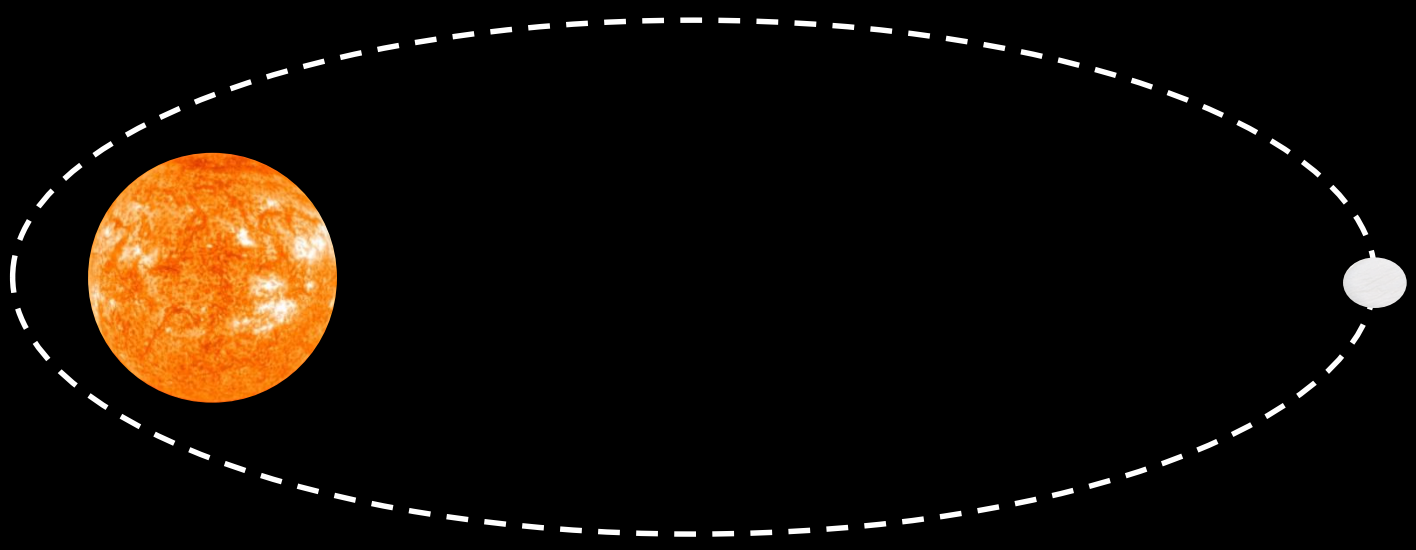

(a) the force on the comet increases as it gets closer to the sun, because force is inversely proportional to distance^2.

(b) the speed of the comet increases because it is accelerated by the increased force.

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Activity – Measuring the acceleration due to gravity

You are going to measure the acceleration due to gravity by dropping an object and timing how long it takes to hit the ground.

1. Time how long it takes for an object to fall 1 metre
2. Repeat at least 5 times and find an average time
3. Use the equations of motion to calculate g

How does your value compare with the reference value of 10 m/s^2?
Can you suggest any reasons for any differences?

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This presentation is produced by Sent Into Space and supports the Classtronauts school space launch programme. The ultimate STEM project, launching a balloon into space is a great idea if you're wondering how to engage your pupils with the science curriculum. We'll visit your school and fly a craft into space right from your playground. Our presenter gives a mission briefing explaining the science behind high altitude flight, answering questions from the pupils before launching an item of your choosing into space. It's the perfect activity for Space Week.

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