

Topic 12

Formation of Planetary Systems

Edexcel GCSE Astronomy Course

12.1 Be able to identify the operation of each of the following in our Solar System:

a gravitational attraction producing regular motion, including the orbits of planets and moons

b tidal gravitational forces producing effects, including ring systems, asteroid belts and internal heating

c gravitational interactions of multiple bodies producing effects such as gradual shifts in orbits, chaotic motion, resonances and the significance of Lagrangian Points (detailed mathematical descriptions not required)

d accidental collisions causing impact craters, changes to orbital motions or planetary orientations

e solar wind affecting comets, planetary atmospheres and the heliosphere

Let's look at these one by one:



a gravitational attraction producing regular motion, including the orbits of planets and moons

We have known for some time that gravitational attraction between bodies in the solar system keeps them in orbits with regular motion. The orbits of planets, asteroids and comets are around the Sun whereas moons orbits their nearest planets.

Creating a solar system of many objects with stable orbits is actually quite tricky as you can find out for yourself using a PhET simulation. Save some time by watching this video first which explains some orbital theories and gives some useful tips for running the sim:

<https://www.youtube.com/watch?v=MS5IUaldBj4>

<https://phet.colorado.edu/en/simulations/my-solar-system>

b tidal gravitational forces producing effects, including ring systems, asteroid belts and internal heating

This site gives some examples of the effects of tidal forces:

<https://chandra.harvard.edu/chronicle/0104/tidal/index.html>

There are different theories for the formation of the asteroid belt which you can read about in detail with gravitational effects being both constructive and destructive:

<https://www.skyatnightmagazine.com/space-science/asteroid-belt-facts-formation/>

Here's a great video on tidal heating - find out what causes it:

<https://www.open.edu/openlearn/ocw/mod/oucontent/view.php?id=69107§ion=4.10>

c gravitational interactions of multiple bodies producing effects such as gradual shifts in orbits, chaotic motion, resonances and the significance of Lagrangian Points (detailed mathematical descriptions not required)

Go to this link for a discussion of multiple body interactions:

<https://www.space.fm/astronomy/planetarysystems/multiplebodies.html>

Make sure you write down simple explanations of resonance and Lagrangian points.

Why are Lagrangian points useful for certain types of satellite orbits?

d accidental collisions causing impact craters, changes to orbital motions or planetary orientations

Make a list of some of the consequences of collisions between objects in our solar system:

<https://www.space.fm/astronomy/planetarysystems/accidents.html>

e solar wind affecting comets, planetary atmospheres and the heliosphere

Watch this video and make notes on all the effects of the solar wind it mentions:

<https://www.youtube.com/watch?v=twB62NYsalg&t=1s>

If you prefer written information, go to this link

<https://www.space.fm/astronomy/planetarysystems/solarwindeffects.html>

And don't forget earlier topics such as Topic 5 and 11 also covered comets and solar wind

12.2 Be able to identify the operation of each of the following interactions in the formation of planets and moons:

a the interaction between tidal gravitational and elastic forces to determine whether a body is broken apart (Roche Limit)

Try the calculations given in this NASA exercise and learn what the Roche limit is and what its consequences are for the formation of moons around planets or planets around stars:

<https://spacemath.gsfc.nasa.gov/moon/5Page49.pdf>

b the interaction between attractive gravitational and elastic forces in determining a body's spherical or irregular shape Find out and write down an explanation using this link

<https://nineplanets.org/questions/why-are-planets-round/>

c the interaction between gravitational and thermal factors in determining the presence of an atmosphere Find out the answers to the questions below from this link:

<http://www.astronomynotes.com/solarsys/s3.htm>

- What is the equation for escape velocity?
- What two factors will affect whether gas molecules can be held in an atmosphere?

12.3 Understand the main theories for the formation of gas giant planets in planetary systems

Recap on these ideas from Topic 11:

Go to this link for an explanation of the current theories of formation and position of the gas giants:

https://lasp.colorado.edu/outerplanets/solsys_planets.php

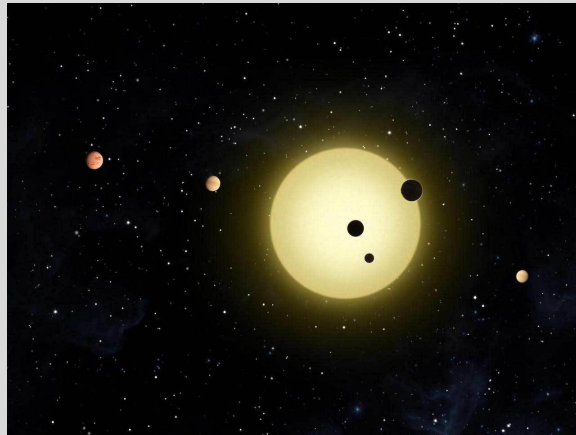
Copy and learn the flow diagrams which summarise 11.7 (and 12.3) very nicely.

12.4 Understand the current methods for discovering systems of exoplanets, including transit method, astrometry and radial velocity measurements

Watch the excellent animations at this link which explain FIVE ways to find exoplanets (including the THREE listed above):

<https://exoplanets.nasa.gov/alien-worlds/ways-to-find-a-planet/>

Write a short explanation of each method in your notes.



12.5 Understand the requirements for life and the possibility of life- forms existing elsewhere, including:

a on Titan

What is one of the biggest, current puzzles about Titan's atmosphere and why could this be a sign of life?

https://www.esa.int/Science_Exploration/Space_Science/Cassini-Huygens/Life_on_Titan

b on Europa

What are the three features of Europa that could sustain life there?

<https://geology.com/stories/13/life-on-europa/>

c on Enceladus

What makes Enceladus one of the best candidates for life elsewhere in the Solar System?

<https://earthsky.org/space/methane-on-enceladus-methanogens/>

d outside our Solar System

Watch these videos about different ways scientists use to find signs of life outside the solar system - make notes on what they are:

https://www.youtube.com/watch?time_continue=1&v=Y0-ljMNIKMw&feature=emb_logo (4:27)

<https://www.youtube.com/watch?v=CIG-xGFshms> (4:42)

12.6 Understand the relevance of the Goldilocks (Habitable) Zones

12.7 Understand how factors in the Drake equation can be used to allow us to estimate the number of civilisations in our Galaxy

What are the eight ingredients for life according to the Natural History Museum?

<https://www.nhm.ac.uk/discover/eight-ingredients-life-in-space.html>

What is the definition of the habitable zone and what affects its distance from a star? Find the answers here:

<https://www.nasa.gov/ames/kepler/habitable-zones-of-different-stars>

Find out what all the parameters in the Drake Equation are, compare it with a newer alternative model and try some calculations of your own here:

<https://www.omnicalculator.com/physics/alien-civilization#the-astrobiological-copernican-limits-a-new-perspective>

12.8 Understand the search for extra-terrestrial intelligence, by receiving radio waves (SETI), including the benefits and dangers of discovering extra-terrestrial life

This thought provoking topic is discussed in this video. Make a note of some of the methods for detecting alien life that are mentioned, what SETI stands for and some of the benefits and dangers of finding alien life that are mentioned by this presenter:

<https://www.youtube.com/watch?v=Qtz1wQT1wO8&t=33s>

