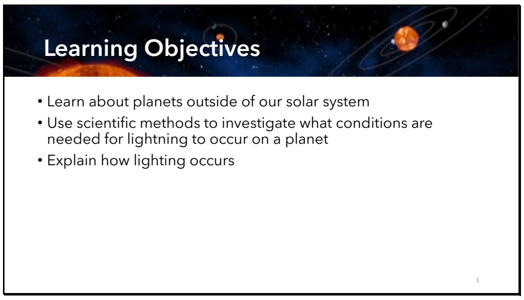
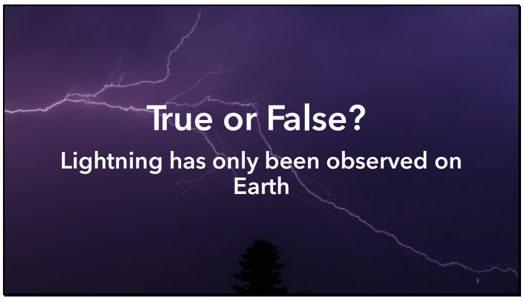
Slide 1



Slide 2

Activity 1: Introductory ‘quiz’ – the aim of this is to introduce the students to exoplanets, and to gauge their knowledge on the topic of exoplanets and lightning

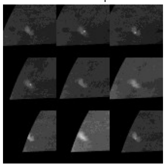
Slide 3



Slide 4

False!

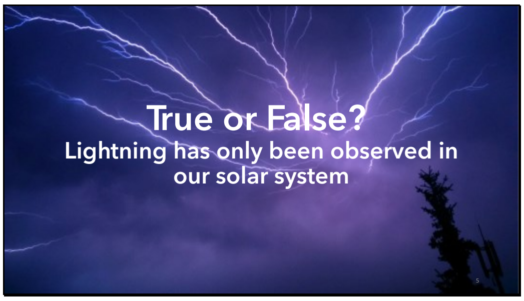
Lighting storms occur on many other planets including Saturn, Jupiter, Uranus, Neptune and Venus! Many of these lightning storms have been observed by NASA and ESA spacecrafts.



Lightning flashes on Saturn's night side in a cloud illuminated by the light from Saturn's rings. Captured by the Cassini spacecraft
Credit: NASA/JPL-Caltech/Space Science Institute/University of Iowa

An illustration of high-altitude electrical storms on Jupiter using data obtained by NASA's Juno mission.
Credit: NASA/JPL-Caltech/SwRI/MSSS/Gerald Eichstädt

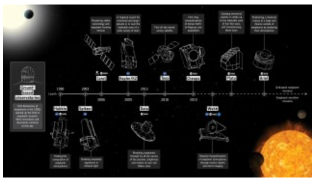
Slide 5



Slide 6

True (for now)

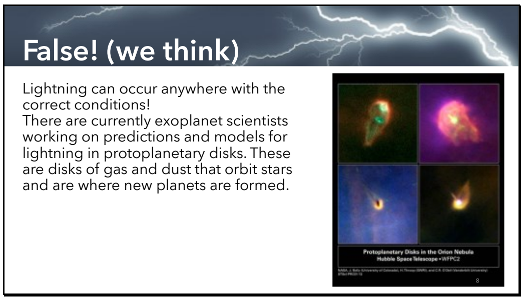
Lightning has been predicted on planets outside of our solar system (exoplanets) and scientists are currently in the process of confirming this



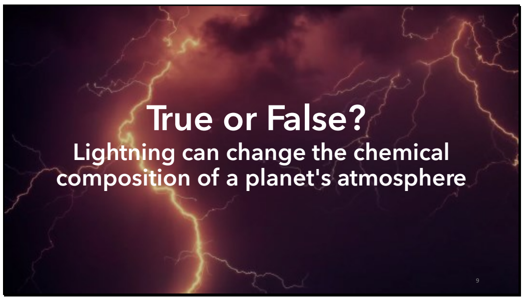
This timeline shows all the space missions that are either dedicated to observing exoplanets or that are able to observe exoplanets
https://sci.esa.int/

Slide 7

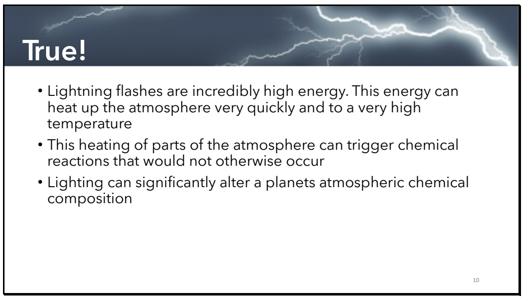
Slide 8



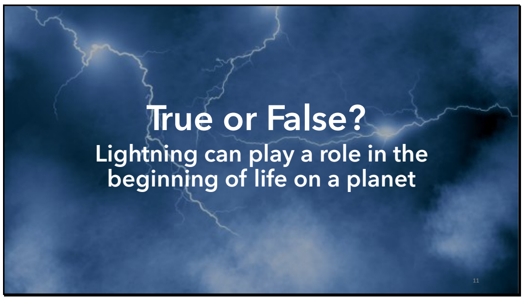
Slide 9



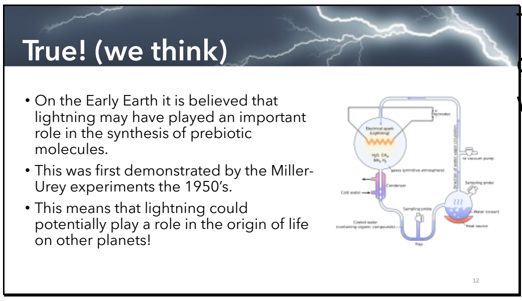
Slide 10



Slide 11

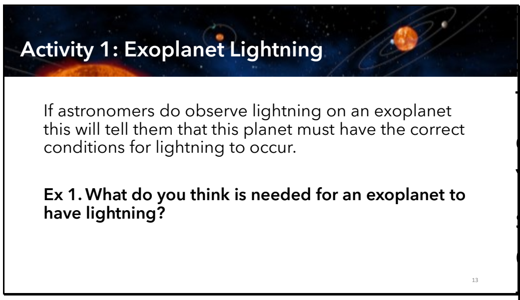


Slide 12



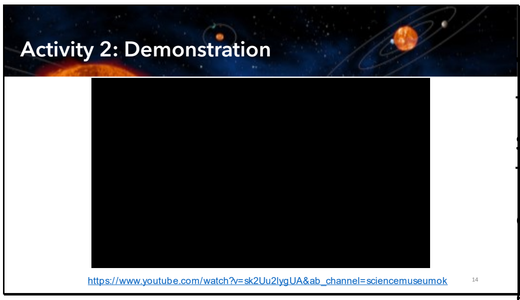
This is only applicable given the exact correct conditions for the planet, which would be very difficult to find!

Slide 13



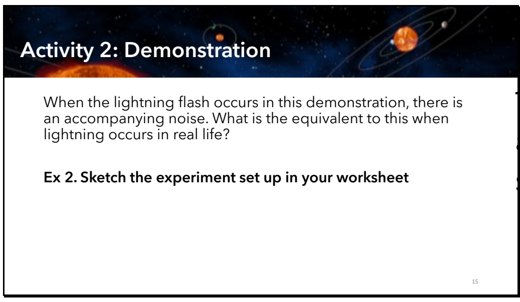
This question should be answered by students in their student worksheets. This can be done either individually or using ‘think, pair, share’.
You may select some students to share their answers with the class.
Correct answers will not be given for this question at this stage, as the question should be answered by the students through their experiments during this lesson.

Slide 14



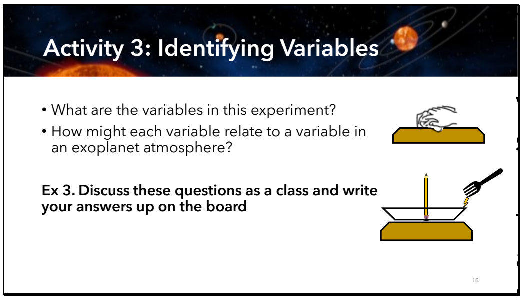
If playing this video from the youtube link, it is important to stop the video at 1:40 (before the scientific explanation)
The demonstration shows the creation of lightning. The physics behind lightning is the same on exoplanets as it is on earth. Because we are doing the experiment on earth, we are limited to using materials that work in the conditions we have on earth, on an exoplanet many different materials and chemicals could be used.

Slide 15



Answer: Thunder.
The flash of lighting heats up the air around it so quickly that it causes a shockwave to travel through the air.

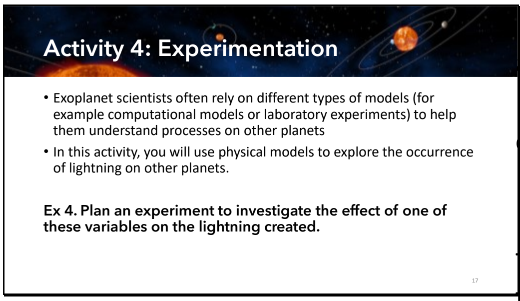
Slide 16



The students should be given a few moments in groups to come up with variables. You may use **think, pair, share for this.**

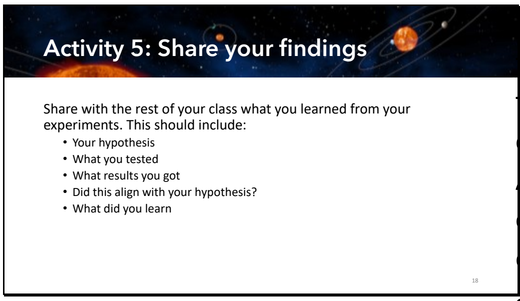
You will then write the variables and their equivalent in an exoplanet atmosphere up on the board. Suggested answers for this can be found in the teacher guide. Students may identify variables that are present in the demonstration that are not present in an exoplanet atmosphere and vice versa, this is because the demonstration has limitations, as many scientific models do.

Slide 17



It is suggested to schedule approximately 25 minutes for the planning and conduction of the experiments, with no more than 10 minutes of this being spent on the planning. You may wish to set a timer for this so student can plan their time accordingly.

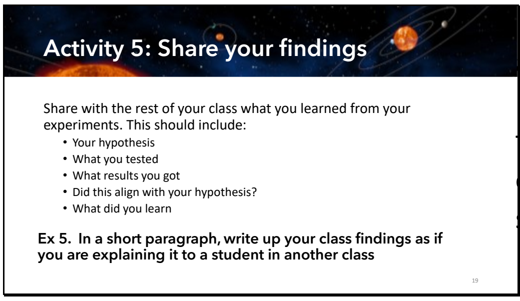
Slide 18



When each group is sharing their findings you may wish to write a a few brief notes of the findings of each up on the board.

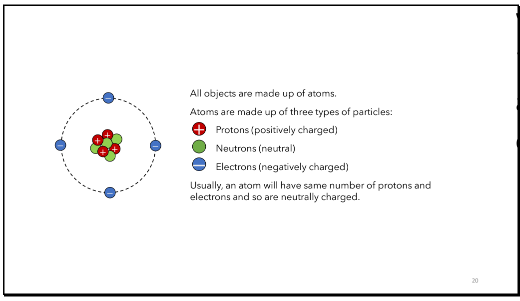
At this point you may wish to point out that often in scientific experiments, the results may not align with our expectations or things may not go as expected but this is an important part of the scientific process and helps us to learn more. Science is a continuous process of questioning, testing and learning.

Slide 19



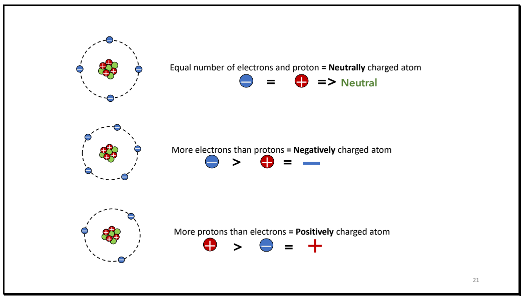
Being able to share your findings is an important part of the scientific process. By explaining their findings to peers this will help students not only practice this skill, but also make sure they understood the content.

Slide 20

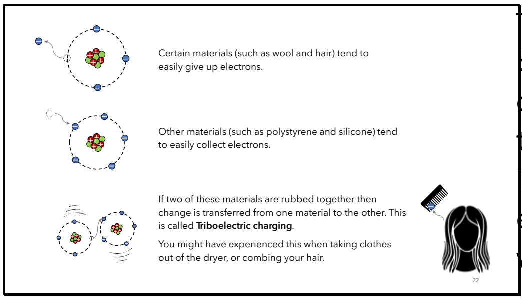


We will now introduce some important scientific concepts. These are a common ground between earth and exoplanets.

Slide 21

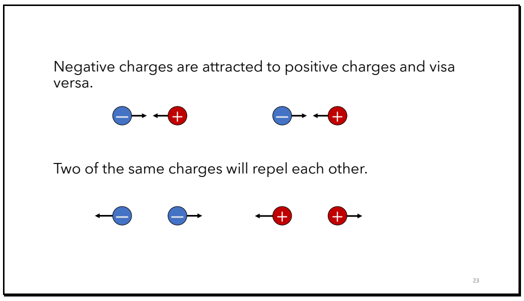


Slide 22

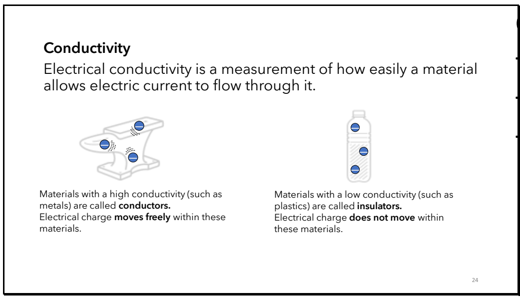


This is important for astronomers because static charge can cause lots of issues inside spacecrafts or telescopes. Static charge within the international space station can cause electrical problems which can be very dangerous!

Slide 23

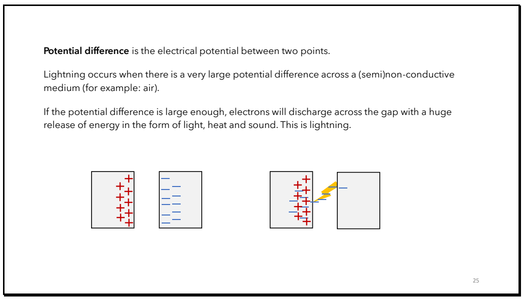


Slide 24

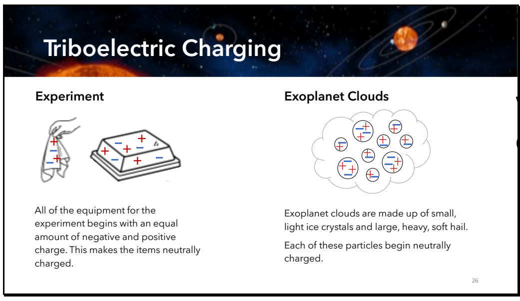


Conductivity is an important concept for astronomers because it helps them to choose the correct materials for any instruments.

Slide 25

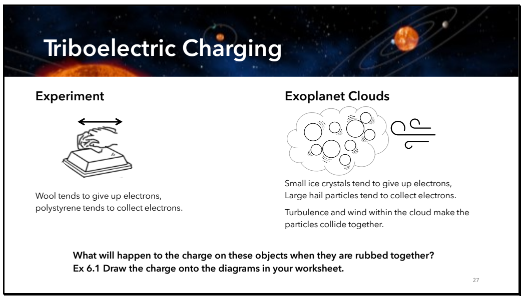


Slide 26

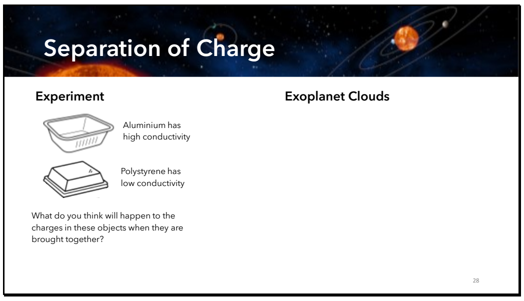


We will now apply what we have learned to both the experiment and what is occurring in clouds on an exoplanet.

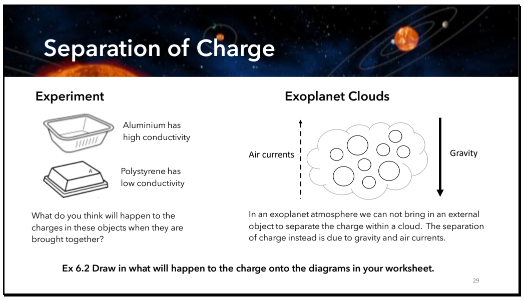
Slide 27



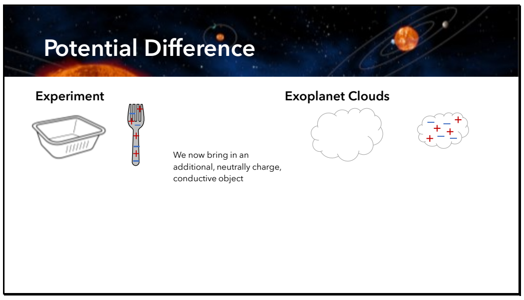
Slide 28



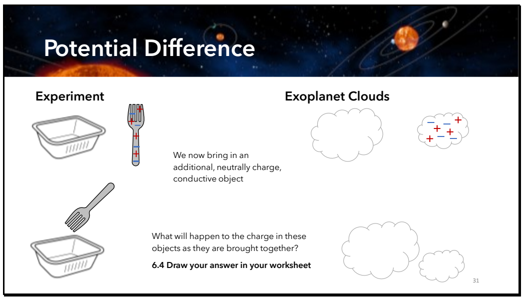
Slide 29



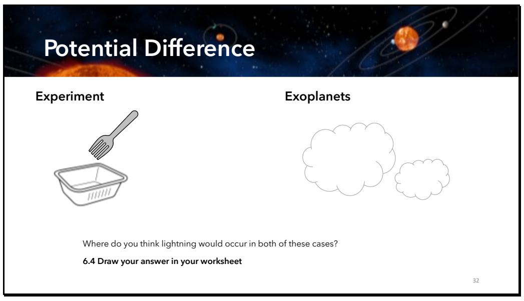
Slide 30



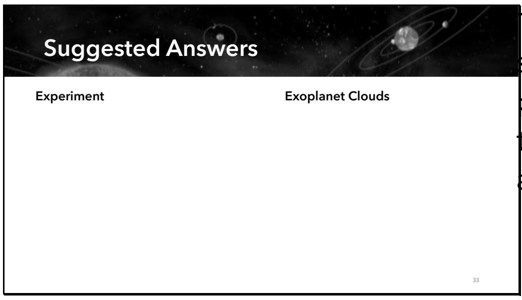
Slide 31



Slide 32

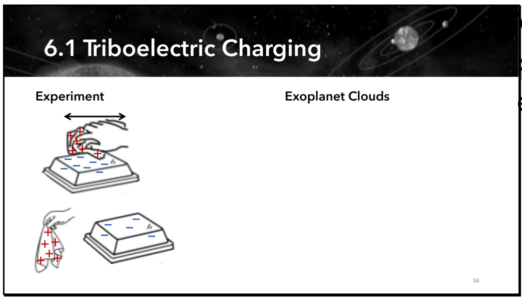


Slide 33



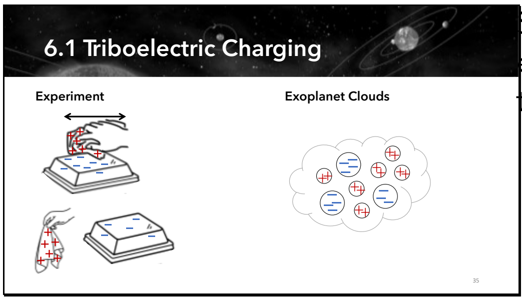
These slides may be useful to show students the answers but it is preferable to have students draw their answers in their worksheets and optionally up on the board.

Slide 34



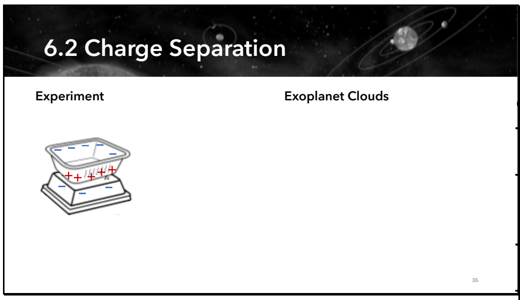
Wool tends to give up electrons, polystyrene tends to collect electrons.

Slide 35



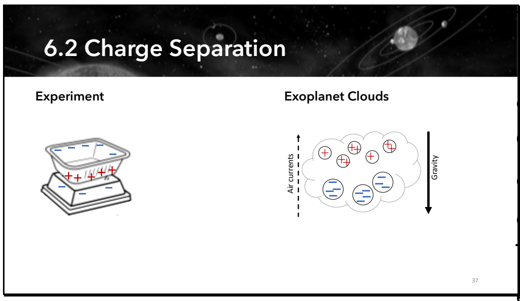
Small ice crystals tend to give up electrons, Large hail particles tend to collect electrons.

Slide 36



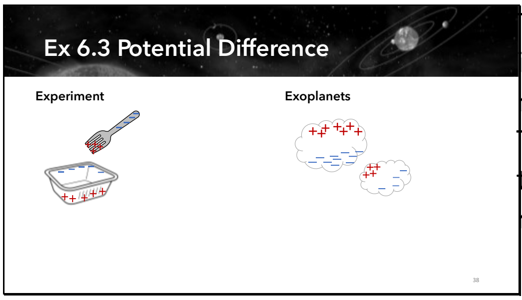
The charges in the metal tray will move because metal is a conductor.
The charges in the polystyrene tray will stay where they are because plastic is an insulator.
The positive charges in the metal tray will be attracted to the negative charge in the polystyrene tray, the negative charge in the metal tray will be repelled.
The top of the metal tray now has a large negative charge.

Slide 37



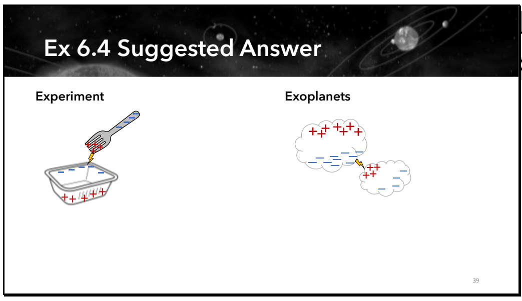
The air currents will blow the particles up (away from the centre of the exoplanet)
Gravity will pull the particles down towards the centre of the exoplanet.
The lighter particles will be less effected by gravity than the heavy particles and the heavy particles will be less effected by the air currents.
This results in the top of the cloud being positively charged and the bottom of the cloud being negatively charged.

Slide 38



The external objects that are brought in are conductive, so the charge will move freely in them.
The opposite charges are attracted to each other, and like charges are repelled.

Slide 39



Lightning will occur at the closest point between the two objects.