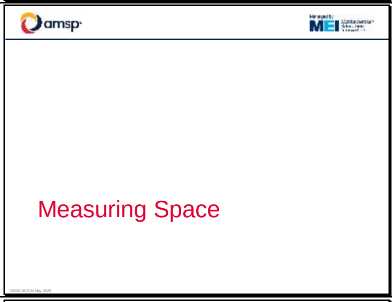
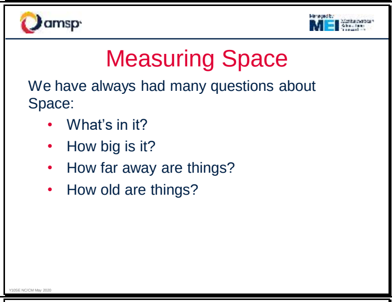
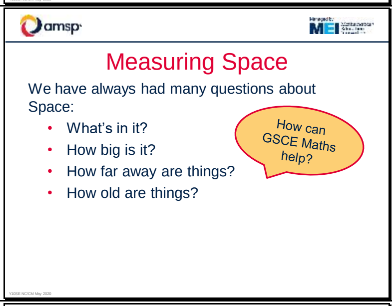
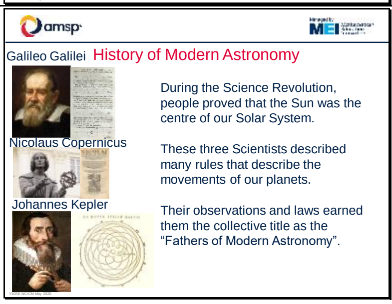
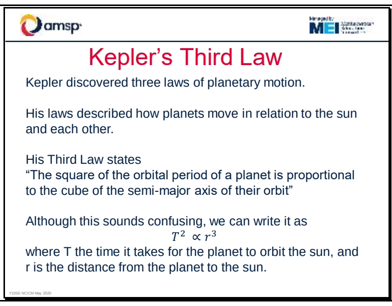
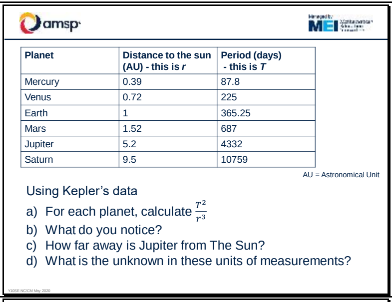
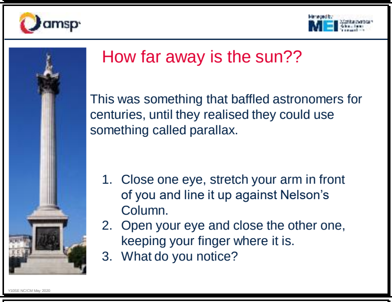
Slide 1	Advanced Mathematics Support Programme®	
Slide 2		Please note that some slides where calculations are done step at a time have been removed from this handout to make printing these notes easier. The numbers have been retained for your reference.
Slide 3		
Slide 4		
Slide 5		Discussion points for students – many students are aware that people used to think that the Sun revolved around the Earth. You can ask why people might have thought that – what would the danger be if we suggested that the Earth wasn't the centre of the Universe? Copernicus' model is based on heliotropism, where the Sun is the centre of the Universe. We now know this not to be true either, indeed the Universe doesn't have a centre. The notion that the Sun was the centre of the Universe was first suggested in 3BC How would you model the motion? These astronomers took thousands and thousands of observations from telescopes, and then had to carry out huge calculations by hand.
Slide 6		Kepler's 1st Law states that planets move in ellipses, and his 2nd Law is about the speed that the planets move at different parts of the ellipse.

<table>
<tr><td>Slide 7</td><td>
</td><td>All the planets are as a fraction of 1AU, which is the distance from the Earth to the Sun.
Without knowing what 1AU is, we have no value for any other distance either.</td></tr>
<tr><td>Slide 8</td><td>
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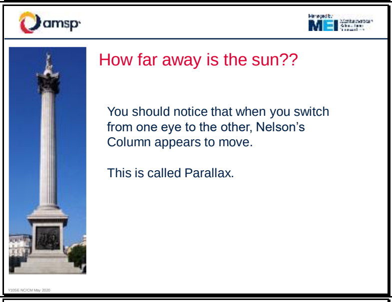
<tr><td>Slide 9</td><td>
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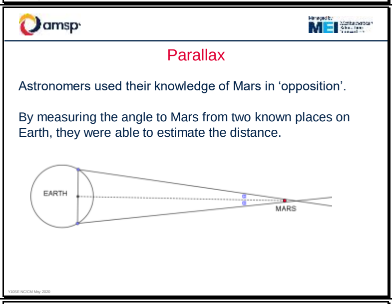
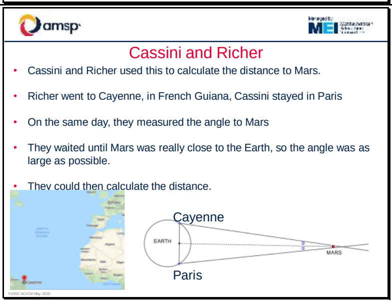
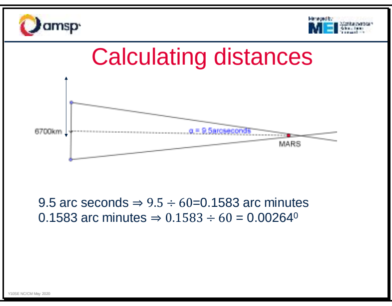
<tr><td>Slide 10</td><td>
</td><td>This is a very simplified diagram of parallax, most likely the object we are looking at will not be equidistant between the two observation points on the Earth which makes the trigonometry more tricky.</td></tr>
<tr><td>Slide 11</td><td>
</td><td>Cassini set Richer out a year in advance so he could accurately measure his position as calculating position on Earth was challenging! He measured position by taking measurements of the stars.
They waited for Mars to be 'in opposition'. More information is available here <u>https://archive.briankoberlein.com/2015/01/08/martian-chronicles/index.html</u></td></tr>
<tr><td>Slide 12</td><td>
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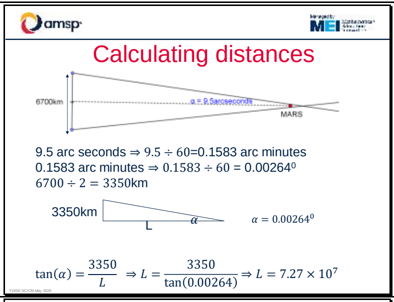
Slide 17



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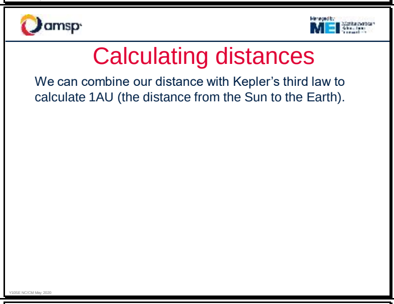

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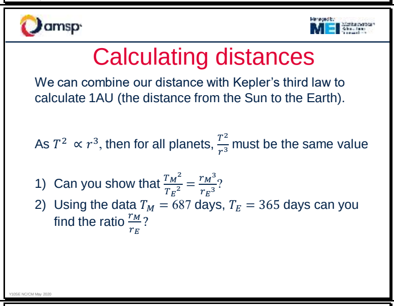

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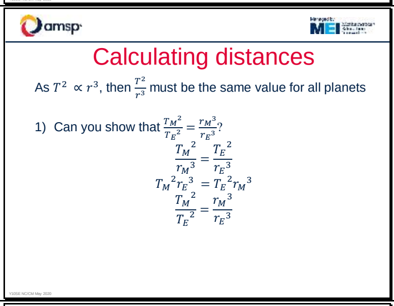

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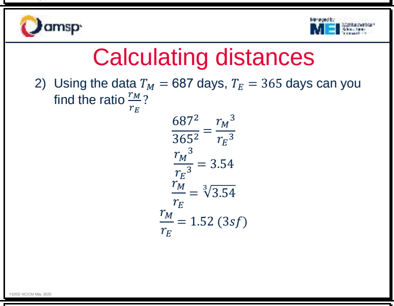

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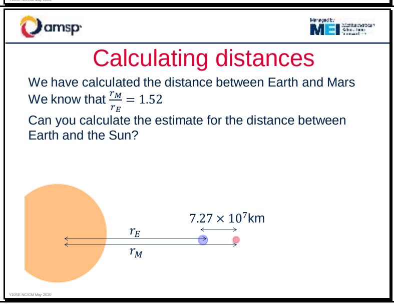

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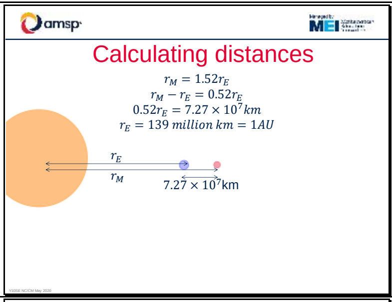

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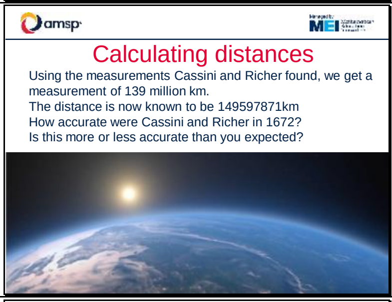
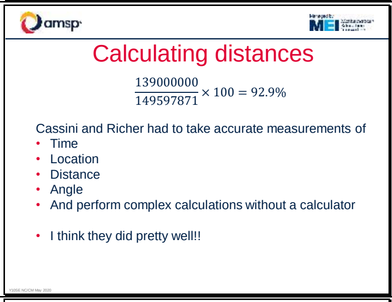


You may wish to discuss whether you want to put in a more accurate number for Cassini and Richer, or a less accurate measurement for the Sun, as these measurements are not to the same number of significant figures.

Slide 30



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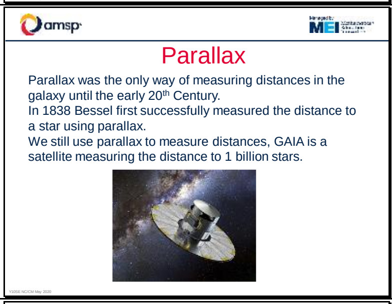
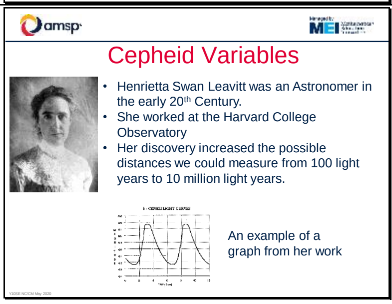


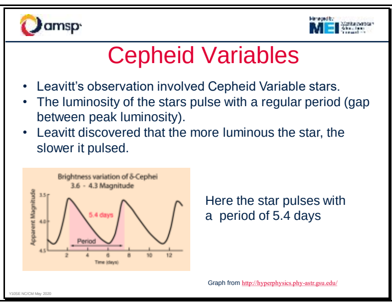
GAIA is an ESA satellite that maps the stars. More information here https://sci.esa.int/web/gaia
You might want to see if students think that 1 billion stars is all the stars in the Milky Way? Or the Universe? It's around 1% of the stars in our 'galactic group' (Milky Way plus a few extras).

Slide 32



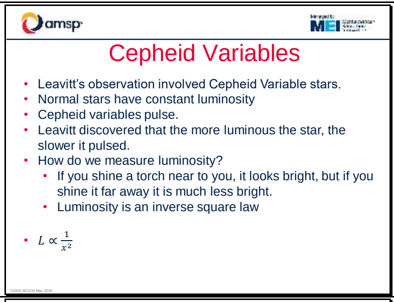
Henrietta Leavitt was one of the 'Harvard Calculators'. She originally took up an unpaid role at Harvard University as she was a woman, but ended up leading a team of astronomers. She died when she was very young, otherwise Hubble was sure she was worthy of a Nobel prize, but they're not awarded posthumously. She became deaf after graduating. More information can be found here https://www.khanacademy.org/partner-content/big-history-project/big-bang/other-materials2/a/henrietta-Leavitt .

Slide 33



Our sun's luminosity varies by 0.1%. This is what makes Cepheid Variables so useful.

Slide 34



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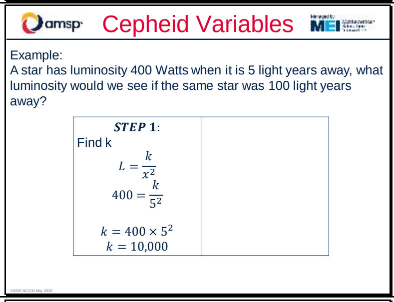

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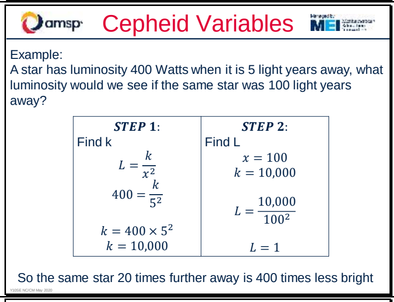

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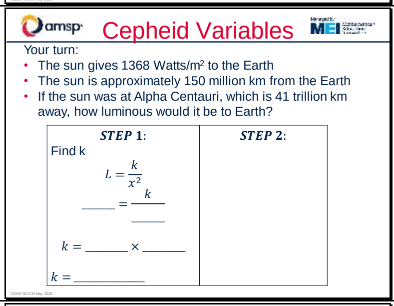

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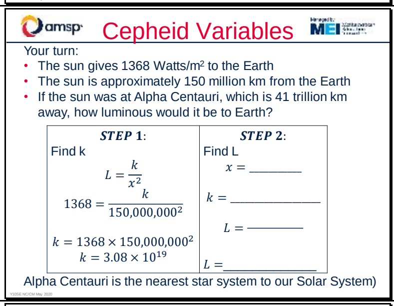

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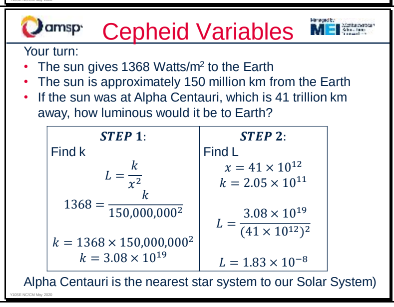
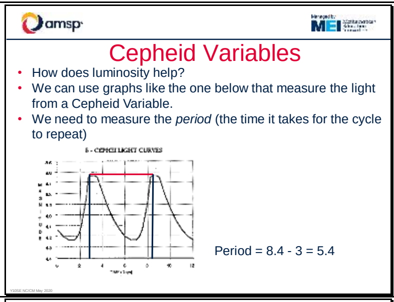
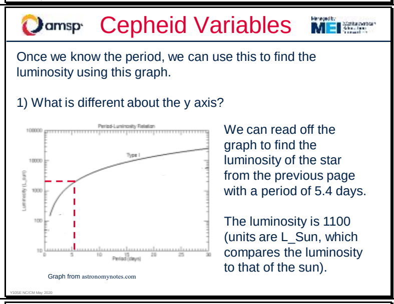
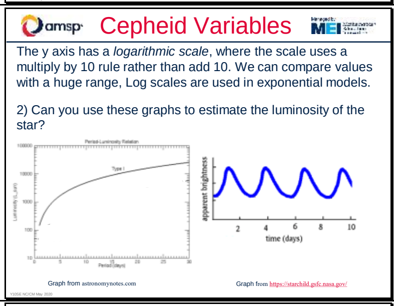
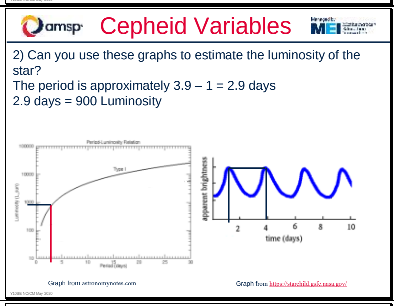
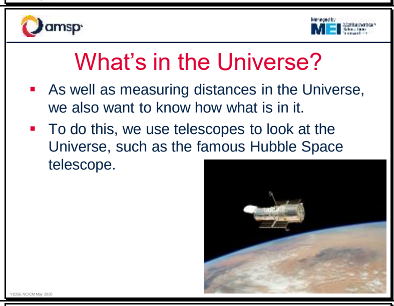
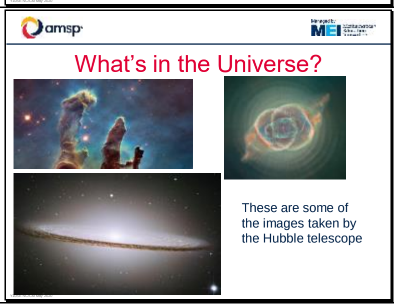


Slide 40		
Slide 41		Students might want to see other examples of logarithmic graphs, and even compare what they would look like on a linear scale. The most recent example is the graph of Covid-19 cases comparing countries https://ourworldindata.org/coronavirus#coronavirus-country-profiles
Slide 42		
Slide 43		
Slide 44		
Slide 45		

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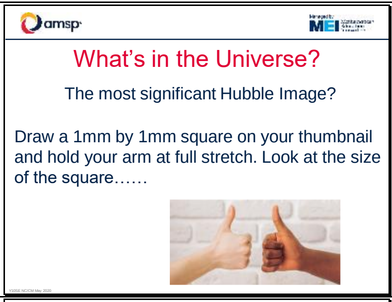

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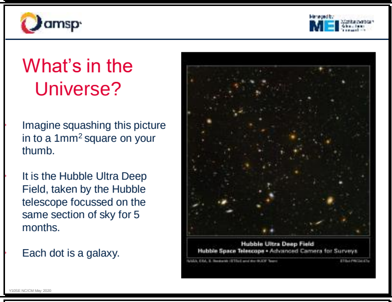

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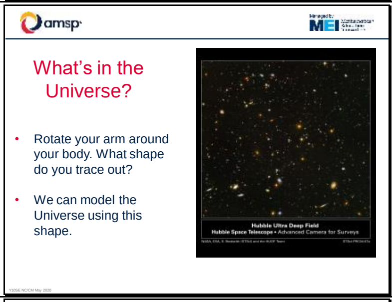

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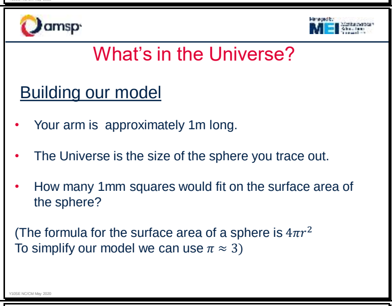

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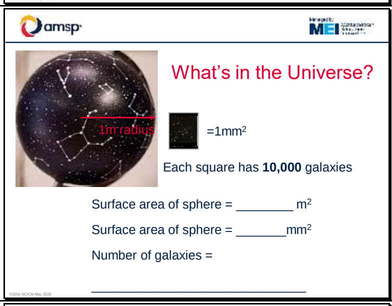

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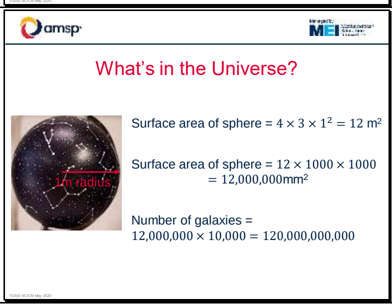
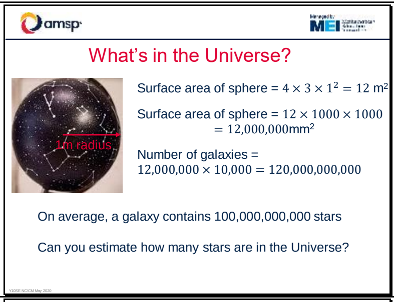
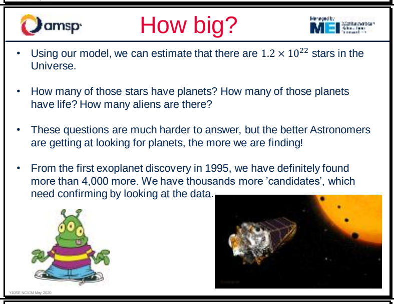
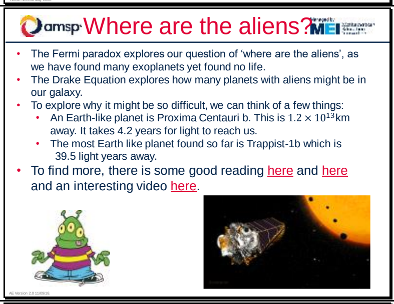
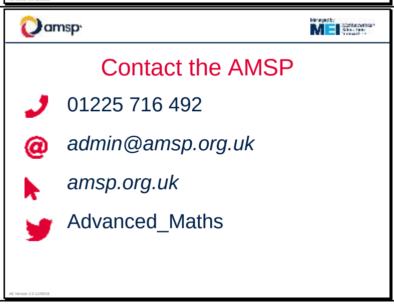


Slide 52		
Slide 53		
Slide 54		More information on the drake equation can be found here https://exoplanets.nasa.gov/news/1350/are-we-alone-in-the-universe-revisiting-the-drake-equation/ and on SETI, which was the institute founded by the work of Drake, can be found here https://www.seti.org/
Slide 55		Stay informed about the AMSP and receive updates: https://amsp.org.uk/subscribe