TEACHER NOTES – ASTRONOMY IN THE NEWS #45

PLANET-KILLER ASTEROID (BUT IT'S MISSING EARTH!)

Slide 2 – Background Science: Near-Earth Objects

The fate of the dinosaurs was a mass extinction event caused by a collision by an asteroid thought to be 10-15 kilometres across. It is, therefore, in the best interests of the human race to have a knowledge of where any potential hazardous asteroids or comets are. This cause is coined "Planetary Defence" and accounts for multiple stages of the process. These are to Assess objects; Search, Detect and Track; Characterise; Plan & Coordinate; and Mitigate.

The Search, Detect and Track aspect of the cause has resulted in the detection of thousands of Near Earth Objects (NEOs). NEOs are those objects that come within 1.3 AU (astronomical units) of the Sun. However, not all of these objects would be hazardous as they are either too small (an asteroid of 35m across is thought to pose a threat to a city) or don't come within 8 million kilometres of the orbit of Earth. However, the objects that are larger than this and do come within this threshold are labelled as Potentially Hazardous Objects.

IMAGES:

1. (Left) The orbits of NEOs drawn in relation to the orbits of Mercury, Venus, Earth, Mars and Jupiter. The objects shown all have a size over 140 m and come within 7.6 million kilometres of Earth.
2. (Top Right) GIF of the NEOs around the Earth. This animation displays that these orbits don't directly cross the Earth (i.e. don't collide with Earth).
3. (Bottom Right) Histogram of sizes of all known NEOs. The vast majority of these objects are not those that would cause catastrophic damage to the entirety of humanity. However, the majority of the detected objects with sizes do meet the threshold for Potentially Hazardous Objects.

Slide 3: Close Encounter: 2022 AP7

The Dark Energy Camera is an instrument built for the Blanco Telescope in Chile with the purpose of investigating the cosmological evolution of the Universe and associated subjects, such as the expansion of the Universe and the dark matter distribution via weak gravitational lensing. However, it was used for a new purpose, to discover NEOs within the orbits of Earth and Venus.

The Dark Energy Camera is a wide-angle camera, able to survey large amounts of the sky at high sensitivity. When used at twilight, it can be used to discover these NEOs. This survey was designed to find objects completely interior to the Earth. However, it found what is called an Apollo-type asteroid. An Apollo-type asteroid is one that has an orbit with a semi-major axis larger than that of Earth but a perihelion distance (nearest point in an orbit) less

than the aphelion (greatest distance) of Earth's orbit. One such object was discovered, and it was a large one, about 1.5 km in size. It will also cross the orbit of Earth, but thankfully it will do so whilst Earth is on the other side of the Sun, posing no threat to us.

This survey is unique in that it uses a fairly large telescope pointing towards the Sun at twilight and has discovered large asteroids. As a result, there are probably a few more kilometre-sized objects to find, especially those with low semi-major axis orbits but high eccentricity.

The article that this resource is built on can be found here:

https://www.theguardian.com/science/2022/nov/01/huge-planet-killer-asteroid-discovered-and-its-heading-our-way

A free, permanent version of the research article can be found here:

https://arxiv.org/abs/2209.06245

IMAGES:

1. (Top left) The three large asteroids discovered by this survey. Two of which don't cross the orbit of Earth, but the third is the Apollo-type which does. This table shows the orbital information where a is the semi-major axis in units of astronomical units (1AU is the distance between the Earth and the Sun), e is the eccentricity of the orbit, i is the inclination of the orbit, H is the h-band magnitude, and diam is the diameter of the asteroid. The defines where the orbit lies.
2. (Bottom left) Cartoon showing the definition of the Apollo-type asteroids and where their orbits lie in relation to Earth's.
3. (Right) Cartoon of one of the other two asteroids discovered, one of the Atira asteroids. An Atira asteroid is one in which whose orbit is completely within that of the Earth. This asteroid, 2021 PH27, has its orbit indicated by the broken green line and never crosses that of Earth.

Slide 4 – Activity: How large are impact craters?

This week's activity is a discussion/estimating activity about impact craters. The asteroid that crosses the path of Earth's orbit is estimated to be between 1.1 and 2.3 km. An asteroid 1km across has a mass of about 1.17 billion tonnes.

The question for the students is how large would an impact crater be for a 1 km asteroid, and a 10 km one. The initial answers may be just the size of the asteroid, which doesn't take into account the "bomb-like" impact they have. The estimates for these sizes are 20 km for 1 km asteroid, and 150 km for a 10 km wide asteroid, which shows the devastating impact an object like this would have!

GCSE Specifications:

Specification	Knowledge Point
Pearson Edexcel Astronomy	8.5