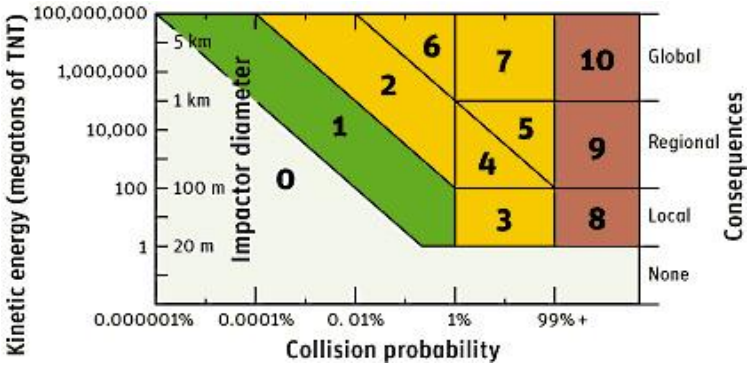
LEARN – How do we categorize potential asteroid or comet impact events?

Learning Objective:
Find out how scientists currently categorise the risk of potential asteroid or comet impact events.

Overview:
Currently, scientists use two scales: the Turin Scale and the Palermo Scale. In this lesson, students will learn that these scales help translate into numbers the risks and consequences of an asteroid impact and which of these bodies have been known to reach higher levels.

Specifics:
The use of scales is a common feature in many knowledge areas. They serve to classify, assess intensities, risks and damages. We can cite as examples the Richter Scale for earthquakes, the Beaufort Scale for the winds and the Fujita Scale for tornadoes.

The impact threats of asteroids and comets, like these other natural disasters, are also measured on scales. Once an asteroid is discovered, its future orbit is calculated to check for the possibility of an Earth impact. When preliminary results point to impact risk, the asteroid is then categorised on the scale.



The Torino Scale
Presented in the 90s during a conference held in Torino, Italy, this scale is mostly used for public information and communication. Their values consider the energy associated with the impact as well as the probability of its occurrence.

It is divided into five colored zones and ranges from 0 - where the probability of a collision is effectively nil or the object will disintegrate in Earth's atmosphere - to 10, where a collision is

certain and could cause global devastation. The Turin Scale is defined only for potential impacts up to 100 years into the future.

No Hazard (White Zone)	**0**	The likelihood of a collision is zero, or is so low as to be effectively zero. Also applies to small objects such as meteors and bodies that burn up in the atmosphere as well as infrequent meteorite falls that rarely cause damage.
Normal (Green Zone)	**1**	A routine discovery in which a pass near the Earth is predicted that poses no unusual level of danger. Current calculations show the chance of collision is extremely unlikely with no cause for public attention or public concern. New telescopic observations very likely will lead to re-assignment to Level 0.
Meriting Attention by Astronomers (Yellow Zone)	**2**	A discovery, which may become routine with expanded searches, of an object making a somewhat close but not highly unusual pass near the Earth. While meriting attention by astronomers, there is no cause for public attention or public concern as an actual collision is very unlikely. New telescopic observations very likely will lead to re-assignment to Level 0.
	3	A close encounter, meriting attention by astronomers. Current calculations give a 1% or greater chance of collision capable of localized destruction. Most likely, new telescopic observations will lead to re-assignment to Level 0. Attention by public and by public officials is merited if the encounter is less than a decade away.
	4	A close encounter, meriting attention by astronomers. Current calculations give a 1% or greater chance of collision capable of regional devastation. Most likely, new telescopic observations will lead to re-assignment to Level 0. Attention by public and by public officials is merited if the encounter is less than a decade away.
Threatening (Orange Zone)	**5**	A close encounter posing a serious, but still uncertain threat of regional devastation. Critical attention by astronomers is needed to determine conclusively whether or not a collision will occur. If the encounter is less than a decade away, governmental contingency planning may be warranted.
	6	A close encounter by a large object posing a serious but still uncertain threat of a global catastrophe. Critical attention by astronomers is needed to determine conclusively whether or not a collision will occur. If the encounter is less than three decades away, governmental contingency planning may be warranted.
	7	A very close encounter by a large object, which if occurring this century, poses an unprecedented but still uncertain threat of a global catastrophe. For such a threat in this century, international contingency planning is warranted, especially to determine urgently and conclusively whether or not a collision will occur.
Certain Collisions (Red Zone)	**8**	A collision is certain, capable of causing localized destruction for an impact over land or possibly a tsunami if close offshore. Such events occur on average between once per 50 years and once per several 1000 years.
	9	A collision is certain, capable of causing unprecedented regional devastation for a land impact or the threat of a major tsunami for an ocean impact. Such events occur on average between once per 10,000 years and once per 100,000 years.
	10	A collision is certain, capable of causing global climatic catastrophe that may threaten the future of civilization as we know it, whether impacting land or ocean. Such events occur on average once per 100,000 years, or less often.

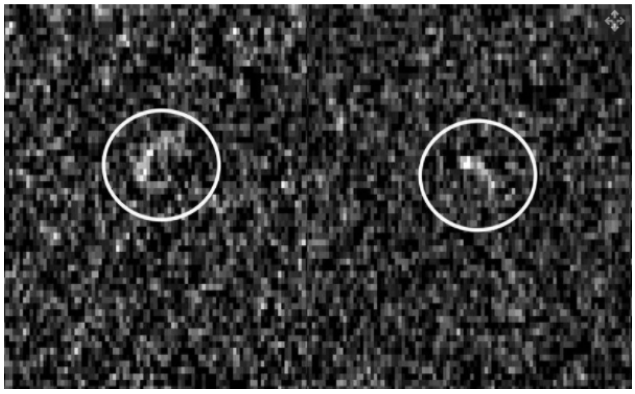
The Palermo Scale
Suggested by astronomers earlier this century, this logarithmic scale is more technical, detailed and better considers the uncertainties involved in the dynamic behavior of asteroids, specifically Near-Efiarth Objects (NEO).

On this continuous scale, the asteroid is given positive or negative numbers. The more negative its number, the less chance it will crash into Earth. If it receives a positive number, it means the risk is more serious and may be a reason for concern.

Both NASA and ESA maintain lists measuring potential impact risks of celestial bodies using the Palermo Scale. See ESA's Risk List and NASA's Sentry: Earth Impact Monitoring pages.

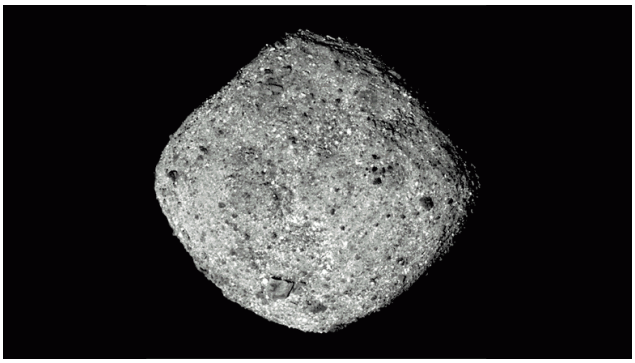
Asteroids that were once high risk:

Apophis - This asteroid has reached the highest level on a scale so far. Discovered in 2004, initial calculations of its orbit have already put this asteroid at level 4 on the Torino Scale and 1.10 on the Palermo Scale for its proximity to Earth in 2029.



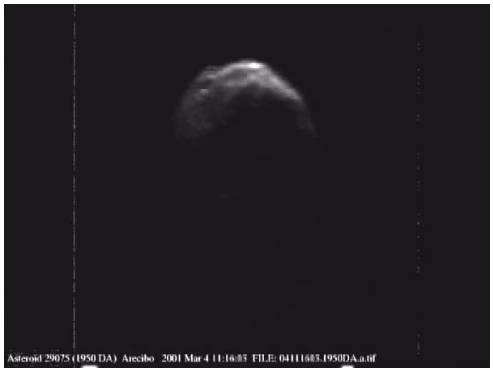
Refining its orbital data through later observations has downgraded Apophis on both scales until it was permanently removed after observations during its 2021 pass.

2004 VD17- Also discovered in 2004, this asteroid reached the level 2 on Torino Scale for its predicted near pass 2102. Like Apophis, new observations refined its orbital data, being removed from the scale a few years later.



Bennu - The asteroid tops the list of objects ranked on the Palermo Scale. Even so, thanks to the data sent by the OSIRIS-REx probe, the chance of an impact with the Earth in the next century is quite reduced, presenting a negative value on this scale.

1950 DA - This asteroid first discovered in 1950 and faded from view, was found again in 2000 bringing bad news. Measurements of its orbit have predicted a potential impact chance for the year 2880, reaching 0.17 on the Palermo Scale. With the refinement of its orbital data, its ranking was changed in 2015, showing a negative index until then.



Both Bennu and 1950 AD are not categorized on the Torino Scale because the chances of future impact exceed 100 years.

Learn more about this subject by visiting these websites:
Torino Scale Table adopted by the International Astronomical Union
Near-Earth objects – a threat for Earth? ESA presentation for students interested in impact effects and consequences
Eyes on Asteroids interactive tool: Apophis, 2004 VD17, Bennu and 1950 DA