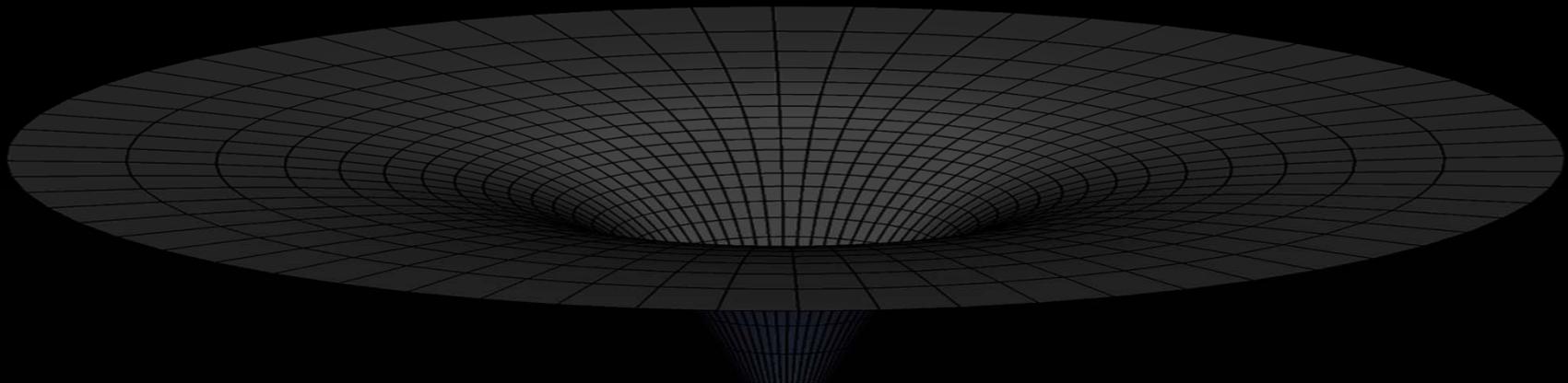


RUBBLE PILES AND BENCHMARKS

Links between asteroids content and science standards go well beyond the obvious astronomy connections. The behavior of asteroids, and particularly “rubble piles” provide a context for discussing forces and motion as well. The following slide connects the underlying physics of the Rubble game to the Project 2061 Benchmarks relating to Forces of Nature and Motion. If you have comments or questions, please contact James Harold at harold@spacescience.org.



Forces of Nature

Motion

Grades 3 through 5

Earth's gravity pulls objects toward it. 4G/1; 4B/1

Changes in speed are caused by forces. 4F/1

Grades 6 through 8

Every object exerts gravitational force on every other object. The force depends on how much mass the objects have and on how far apart they are. The force is hard to detect unless at least one of the objects has a lot of mass. 4G/M1

An unbalanced force acting on an object changes its speed or direction of motion, or both. 4F/M3a

The sun's gravitational pull holds the earth and other planets in their orbits, just as the planets' gravitational pull keeps their moons in orbit around them. 4G/M2

If a force acts towards a single center, the object's path may curve into an orbit around the center. 4F/M3b

Grades 9 through 12

Gravitational force is an attraction between masses. The strength of the force is proportional to the masses and weakens rapidly with increasing distance between them. 4G/H1

The change in motion (direction or speed) of an object is proportional to the applied force and inversely proportional to the mass. 4F/H1*

All motion is relative to whatever frame of reference is chosen, for there is no motionless frame from which to judge all motion. 4F/H2

Whenever one thing exerts a force on another, an equal amount of force is exerted back on it. 4F/H4

Any object maintains a constant speed and direction of motion unless an unbalanced outside force acts on it. 4F/H8** (SFAA)

Finding NEO/Rubble Benchmarks Alignment

<http://killerasteroids.org/educators.php>

Benchmarks from:

<http://www.project2061.org/publications/bsl/online/index.php?chapter=4>