**Black holes**

* Studied via accretion disks, quasars
* They warp space time
* Gravity increases as you get closer
* Still spin due to the conservation of the angular momentum of the star
* Anything that passes the event horizon will end up at the singularity and add to the black hole’s radius and mass
* Singularity is an infinitely dense point
* Stellar mass black holes form from high mass stars after a supernova occurs and the core has a mass of at least 3 times the mass of the sun
* Common misconception that they suck up nearby material, if the sun were replaced by an equally massive black hole, nothing would change for the Earth apart from temperature
* If you were to fall into one, time would appear to slow down from the outside observer’s point of view, whereas time would speed up from your point of view
* Also from an observer’s perspective your descent towards the black hole would appear to move slower and slower as you approached the event horizon, but they would never see you cross it due to the light you emitted not being able to escape
* Instead the light undergoes gravitational redshift so the outside observer would see you become more redshifted until you slowly disappeared
* Mass is so large that tiny changes in position can have massive increases in gravity, this is known as a tidal force
* Theory that there is a supermassive black hole at the heart of every large galaxy
* Largest known supermassive black hole is S5 0014+81, about 40x109 times the mass of the Sun, 236.7x109 km in diameter
* Material caught in the black hole’s gravity is compressed into a molecular width stream
* The photon sphere is a region where light can neither leave nor get dragged into the black hole, so it orbits the black hole
* Light from behind the black hole gets curved around the black hole due to its gravitational field, this is known as gravitational lensing
* The area of material above the event horizon is known as the accretion disk, in which the energy of the motion of the dust, particles and material is converted to heat, so it burns very bright and emits an observable light
* The light drives winds of gas back out of the black hole, known as quasars
* Black holes could affect the orbits of celestial bodies such as stars and planets if they are close enough but not too close to be drawn in
* They play a vital role in the formation of galaxies and the evolution of the universe

Theory of hawking radiation:

* Virtual particles come into existence and then annihilate each other
* If a pair of these particles come into existence on the edge of an event horizon then one particle will be drawn into the black hole and one will escape and become a real particle in the universe
* Hence the black hole loses energy, slowly at first and the rate of energy loss increases as the black hole becomes smaller meaning an exponential process
* The black hole radiates energy at increasing temperatures as it decreases in size
* This process takes huge amounts of time (a solar mass black hole would take 1064 years to evaporate under such conditions)

**Binary system**

* Stellar black holes in binary systems are observable when mass transfer occurs between the black hole, formed from the primary star, and the companion star (mass transfer from companion to the black hole)
* As the matter form the companion star falls into the black hole, it heats up by several hundred million degrees and releases energy in the form of x-rays
* Therefore blackholes can be observed using x-ray observations

National Geographic, 2018. *Black Holes 101*. [video] Available at: <https://www.youtube.com/watch?v=kOEDG3j1bjs&ab\_channel=NationalGeographic> [Accessed 12 March 2021].

Kurzgesagt - In a Nutshell, 2015. *Black Holes Explained - From Birth to death*. [video] Available at: <https://www.youtube.com/watch?v=e-P5IFTqB98&ab\_channel=Kurzgesagt%E2%80%93InaNutshell> [Accessed 12 March 2021].

VSauce, 2012. *Travel INSIDE a Black Hole*. [video] Available at: <https://www.youtube.com/watch?v=3pAnRKD4raY&ab\_channel=Vsauce> [Accessed 12 March 2021].

TED-Ed, 2018. *Could the Earth be swallowed by a Black Hole?*. [video] Available at: <https://www.youtube.com/watch?v=e9TLbZuvsko&ab\_channel=TED-Ed> [Accessed 13 March 2021].

En.wikipedia.org. 2021. *Stellar black hole*. [online] Available at: <https://en.wikipedia.org/wiki/Stellar\_black\_hole> [Accessed 13 March 2021].