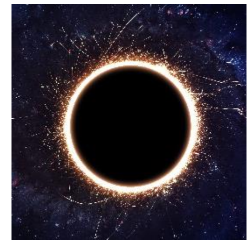
CONCEPT: Black Holes

● A black hole has enormous mass in a relatively tiny space. Not even light can escape!



- The Schwarzschild Radius equation relates the mass and _______ of black holes.

R_S = ________

CONSTANTS
c = 3×10^8 m/s Speed of Light

● The surface of Schwarzschild Radius is called the "event horizon", boundary where nothing escapes.

EXAMPLE: A team of astronomers imaged a black hole at the center of galaxy M87. By observing orbiting objects close to it, they've determined that any objects closer than 120 AU fall in and never escape. What is the mass of this black hole, in terms of solar masses?

EQUATIONS	CONSTANTS
$R_S = \frac{2GM_{BH}}{c^2}$	G = $6.67\times10^{-11}\ \frac{m^3}{kg\cdot s^2}$ c = 3×10^8 m/s $M_{Sun} = 2\times10^{30}$ kg 1 AU = 1.5×10^{11} m

PRACTICE: Astronomers have found a small, but incredibly massive object at the center of our Milky Way galaxy, and suspect it is a black hole. A cloud of gas orbits this object at 1.8×10^5 m/s every 78,500 years. a) What is the mass of this alleged black hole? b) How large is this black hole?

EQUATIONS	CONSTANTS
$F_G = \frac{Gm_1m_2}{r^2}$ $r = R + h$	$G = 6.67\times10^{-11} \frac{m^3}{kg\cdot s^2}$
$g_{surf} = \frac{GM}{R^2}$ $g = \frac{GM}{r^2}$	$M_E = 5.97\times10^{24}$ kg
$v_{sat} = \sqrt{\frac{GM}{r}}$ $v_{sat} = \frac{2\pi r}{T}$ $T_{sat}^2 = \frac{4\pi^2r^3}{GM}$	$R_E = 6.37\times10^6$ m $r_{Sun\text{-}Earth} = 1.5\times10^{11}$ m $c = 3\times10^8$ m/s
$R_S = \frac{2GM_{BH}}{c^2}$	

EXAMPLE: Suppose the Sun were instantly replaced by an Earth-sized black hole. What would the net acceleration of objects on Earth be due to this black hole? Assuming the Earth stayed in place, would you be lifted off the Earth's surface?

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