CENTRIPETAL FORCE

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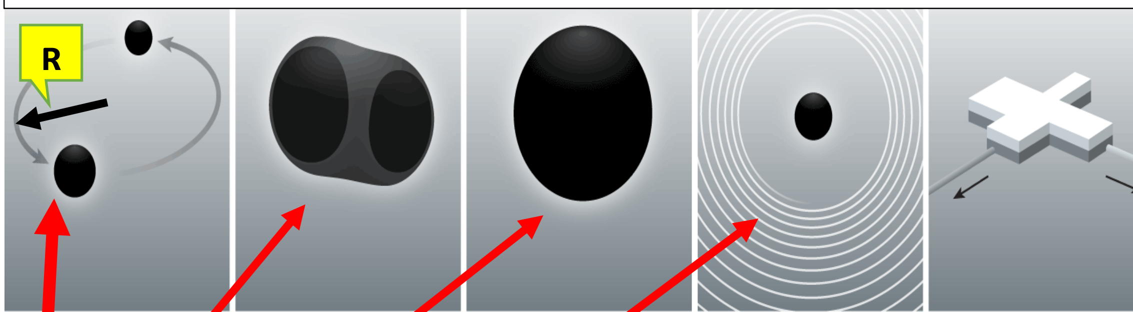
Gravitational Waves Detected, Confirming Einstein's Theory

INTRODUCTION: Kepler's 3rd. Law is followed by the circling black holes at left. $F_C = G\,m\,M/R^2 = m\,v^2/R$, yielding… $M = R\,v^2/G$ (eq. 1) or since $v = 2\pi R/T$, $M = 4\pi^2/G\,[R^3/T^2]$ (eq.2), R = radius of black holes circling each other.



HINTS: **mass of sun = 2×10^{30} kg.**

$G = 6.67 \times 10^{-11}$ N m²/kg.²

C = speed of light = 3×10^8 m/s

TWO BLACK HOLES
About 1.2 billion years ago in a distant galaxy, a pair of black holes circled each other. The larger black hole was 36 times the mass of our sun, and the smaller one 29 times.
COLLISION The intense gravity accelerated the black holes to half the speed of light, pulling them closer and carving distortions in space and time. In a fraction of a second, the pair collided and merged into an irregular shape.
RING DOWN The unstable blob smoothed itself into a sphere, a process called ring down. Three solar masses' worth of energy were vaporized in a storm of gravitational waves, distorting space and time and leaving a new black hole 62 times the mass of the sun.
GRAVITATIONAL WAVES
The invisible waves rippled outward at the speed of light. But waves fade with distance, and when they finally reached Earth, the distortions were too small to be measured above the heat, noise and other vibrations of our planet.
DETECTION LIGO is a pair of L-shaped observatories 1,900 miles apart. Ultra-pure mirrors at the ends of each arm are isolated from vibrations. Passing gravitational waves push and pull the arms, changing the length of tunnels by less than the width of a proton.
A CHIRP On Sept. 14, LIGO's detectors measured their first vibrations from a gravitational wave. Translated to sound, it was a short chirp, the billion-year-old echo of the collision of those two black holes.

A team of scientists announced **on Thursday they had heard and recorded the sound of two black holes colliding a billion light-years away, a fleeting chirp** Thursday that fulfilled the last prediction of Einstein's general theory of relativity. the last waltz of a pair of black holes shockingly larger than astrophysicists had been expecting. **One of them was 36 times as massive as the sun, the other 29. As they approached the end, at half the speed of light, they were circling each other 250 times a second.** And then the ringing stopped as the two holes coalesced into a single black hole, a trapdoor in space with the equivalent mass of 62 suns.All in a fifth of a second, Earth time.(***Note: see other Newspaper estimates of frequency below***

INTRODUCTION(CONTINUE The Guardian, British Newspaper 2/12:16 At the beginning of the signal, their calculations told them how stars perish: the two objects had begun by **circling each other 30 times a second. By the end of the 20 millisecond snatch of data, the two had accelerated to 250 times a second before the final collision and a dark, violent merger. The Washington Post 2/12/16 These black holes were each approximately the diameter of a major metropolis. They orbited one another at a furious pace at the very end, speeding up to about 75 orbits per second** — warping the space around them like a blender cranked to infinity until finally the two black holes became one. **Lets take the frequency of their orbit to be 75/s.** since this collision while orbiting each other happens in less than a second.
QUESTIONS: (a) Find total mass(M) of these two black holes? They circle this center of mass. (b) Find half the speed of light? (c) Find R during the collision orbit using eq. 1 from Kepler's 3rd law? (d)If the frequency is taken to be 75 rev/s, find their period T? (e) Find R during the collision orbit using eq. 2 from Kepler's 3rd Law? (f) Comment on finding R these two ways?

ANSWERS: (a) 130×10^{30} kg. , (b) 1.5×10^8 m/s (c) 385 km. , (d) 1.3333×10^{-2} s. , (e) 339 km. , (f) Quite close considering we are dealing with black holes we cannot see and speed of light and period are good estimations only.