CENTRIPETAL FORCE, GRAVITY, KINEMATICS Units 14 ,4 & 5

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New Satellites to Map Gravity More Precisely

WASHINGTON, March 18— No one thinks that much about gravity, one of the most powerful, yet subtle, forces on the earth. It is just there, seemingly never changing, holding feet to the ground.

Now scientists say it is time for a new look at gravity. Minute variations around the globe, they say, can tell us about the earth and what's going on beneath the surface of the land and the oceans, where dynamic processes are constantly moving around masses of material. To get the most detailed measurements ever taken of these changes, scientists have launched **the Gravity Recovery and Climate Experiment, or Grace.**

The project, sponsored by the National Aeronautics and Space Administration and the German Aerospace Center (or DLR), consists of a pair of satellites nicknamed Tom and Jerry, which will follow and monitor each other in space and, in the process, produce a gravity map of the planet 100 times as accurate and detailed as any done before. Both 950-pound satellites are to fly in the same **311-mile-high circular orbit** that crosses the poles of the planet, as it turns beneath them during their **16 orbits each day**. More important, one satellite is to trail the other by 137 miles, each using microwave range finders to measure the precise distance between the two, which is the key to the experiment. **Sir Isaac Newton** formulated the basic law of gravity in the 17th century***. All objects, he said, attract one another with a force that is proportional to their masses and that is dependent upon the distances between them.*** Although the force of gravity is relatively constant everywhere on earth, small variations exist because the planet is not a homogeneous structure with equally distributed mass. The planet is lumpy, with materials of different densities scattered above and below the surfaces of land and water. To sense gravity in free-fall, GRACE will deploy a pair of identical satellites in the same orbit -- one satellite 220 km (137 miles) ahead of the other. As the pair circle Earth, regions of slightly stronger gravity will affect the lead satellite first, pulling it slightly away from the trailing satellite. By monitoring the distance between the two with extraordinary precision (the satellites can sense a change of separation of one micron -- about 1/50th the width of a human hair), GRACE will be able to detect minute fluctuations in the gravitational field.

Left: The twin GRACE satellites will use hyper-sensitive microwave range finders to measure the distance between them

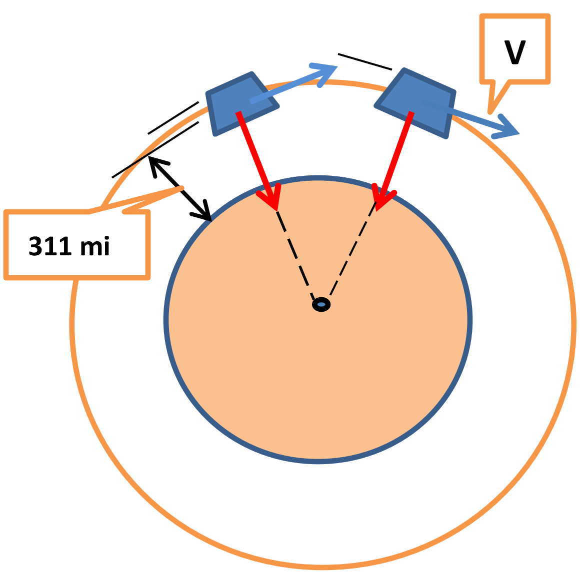
HINTS: **1609 m/mi.**
Earth radius = R_e
6.378×10^6 m.

Gravitational constant = 6.673×10^{-11} Nm^2/kg^2

Earth mass = 5.9742×10^{24} kg. = M_e

Gravity supplies the needed centripetal force to keep GRACE in orbit around the earth.

Equation (1) below
$(G m M_e)/R^2 = m V^2/R$
$R = R_e$ + 311 mi(in m.)



QUESTIONS: (a) Find 311 mi in meters?
(b) Find $R = R_e$ + 311 mi.(in meters) ?
(c) Find speed of satellite knowing V =C (circumference)/T , where T= period of satellite? Note in article the satellite makes 16 rev./day.
(d) Using equation (1) at lower left find the speed of the satellite?
(e) Is V in (c) & (d) the same? Possibly why the slight difference?

ANSWERS: (a) 0.5004×10^3 meters
(b) 6.8784×10^6 meters,
(c) V = ~ 8.0×10^3 m/s
(d) V = ~7.606×10^3 m/s