# Worksheet 4.1
# Gravitational Force

1. A piece of space debris has a mass of 4 kg. It is located 2000 m from an asteroid. If the force of gravity is 0.6 N between them, what is the mass of the asteroid?

2. A $6x10^{12}$ kg moon in a distant galaxy experiences a 1 N force of attraction between it and a $10x10^{30}$ kg planet. How far apart are they?

3. What is the force of gravity between earth and the moon? The earth's mass is $5.98 \times 10^{24}$ kg, the distance from the earth to the moon is $3.90 \times 10^{8}$ m. The mass of the moon is $7.30 \times 10^{22}$ kg.

4. You weigh 458 N on earth, but you are on Mars. Here's some data on Mars: radius = $3.38 \times 10^{6}$ m, mass = $6.42 \times 10^{23}$ kg. (a) What is the acceleration of gravity on Mars? (b) How much do you weigh on Mars? (c) If you drop a 3.50 kg rock from the surface of Mars and it falls a distance of 1.20 m, how fast will it be going just before it hits the surface?

5. If the mass of Mercury is $3.3x10^{23}$ kg and its radius of $2.4 \times 10^{6}$ m, estimate the gravitational acceleration (g) at the surface of Mercury.

6. An object of mass 0.5 kg is transported to the surface of Planet X where the object's weight is measured to be 20 N. The radius of the planet is $4 \times 10^{6}$ m. (a) What is the mass of the planet? (b) What free fall acceleration will the 0.5 kg object experience when transported to a distance of $2.0 \times 10^{6}$ m from the surface of the planet? (no longer on the surface)

7. Saturn has many moons that orbit it. Saturn has a mass of $5.68 \times 10^{26}$ kg.
   a. The closest moon to Saturn, Mimas, has an orbital radius of 185,000,000 m from Saturn's core. What is the tangential velocity of Mimas as it orbits?

   b. What centripetal force does Mimas (mass = $3.8 \times 10^{9}$ kg) experience due to Saturn's gravitational pull?

   c. Titan has a tangential velocity of 5,580 m/s. What is its orbital radius?

   d. Dione has a mass of $11 \times 10^{20}$ kg and a diameter of 1,123,000 m. What is the acceleration due to gravity on the moon's surface?

   e. Dione is located 377,000,000 m from Saturn. What is the force of gravity between Dione and Saturn?

   f. Rhea has an orbital radius of 527,000,000 m and experiences a gravitational force of $3.1 \times 10^{20}$ N. What is the mass of Rhea?

8. Fill in the missing information from the table below.

| | Saturn | Titan | Prometheus |
|---|---|---|---|
| Force gravity from Saturn | X | | |
| Gravitational Constant (g) | | 1.352 $m/s^2$ | |
| Radius | $5.44 \times 10^{7}$ m | $2.57 \times 10^{6}$ m | $4.3 \times 10^{4}$ m |
| Distance from Saturn | X | | $1.4 \times 10^{8}$ m |
| Mass | $5.6846 \times 10^{26}$ kg | $1.3 \times 10^{24}$ kg | $1.6 \times 10^{17}$ kg |
| Period about Saturn | X | 16 days | |