# UNIVERSAL GRAVITY AND KEPLER'S LAWS WORKSHEET

$G = 6.67259 \times 10^{-11}$ (N•m$^2$)/kg$^2$

**Earth**

Mass.............................................. 5.98 X 10$^{24}$ kg
Radius........................................... 6.38 X 10$^6$ m
Mean distance from the Sun.......... 1.50 X 10$^{11}$ m

**Moon**

Mass.............................................. 7.35 X 10$^{22}$ kg
Radius........................................... 1.74 X 10$^6$ m
Mean distance from the Earth........ 3.85 X 10$^8$ m

**Sun**

Mass.................. 1.99 X 10$^{30}$ kg
Radius................ 6.96 X 10$^8$ m

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**1** What is the force of attraction between a 60.0 kg student in the senior parking lot and the school? The distance between the two is 100.000 m and the mass of the school 65,000,000 kg.

**2** You're on a date with "the significant other." You are getting close. Your center of masses are 0.50 meters apart. If you have a mass's of 50.00 kg and 70.00 kg then what is the actual scientific force of attraction between the two of you?

**3** Two asteroids, (m$_1$ = 1.00 X 10$^{12}$ kg and m$_2$ = 5 X 10$^{12}$ kg), are floating in space. The force of attraction between them is 10.000 N. How far apart are their centers of mass?

**4** In a car race, the force of attraction between the 1st and 2nd place cars is 3.0349 X 10$^{-7}$N. If the 1st place car has a mass of 700 kg and the 2nd place car has a mass of 650 kg, then what is the distance between the two cars?

**5** While on the surface of the the Earth a student has a weight of 450 N. If she is moved twice as far from the center of the Earth, then how does hew new weight compare to her old?

**6** How many Earth Radii distances could fit between the center of the Earth and the Center of the moon when it is in orbit around the Earth? If the same 50 kg student in problem #5 is moved out from the surface of the Earth to this distance away from the center of the Earth, then how does her new weight compare to her old?

**7** An alien space craft is out in space leaving an unknown planet. It detects the pull of gravity due to this unknown planet to be 100 N. Later the alien rechecks the pull on their space craft and detects it to be 33 N. By what factor has their distance changed as they left the unknown planet?

**8** The space shuttle travels at 17,000 mph, 7,589.288 m/s while in orbit. How far away from the <u>SURFACE OF THE EARTH</u> is the shuttle?

**9** How fast is the moon traveling as it orbits the Earth?

**•10** A geosynchronous orbit is one where a satellite orbits the Earth with the <u>SAME</u> period of motion as the Earth on it own axis. How far from the center of the Earth is the Satellites orbit?

**11** Using Kepler's 3rd Law of Planetary motion, determine the distance between the center of the Earth and the center of the <u>Moon</u>.

**12** Using Kepler's 3rd Law of Planetary motion, determine the distance between the center of the Earth and the center of the <u>Sun</u>.

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**13** A planet is in orbit as shown below. Where are the two possible locations for a Sun?
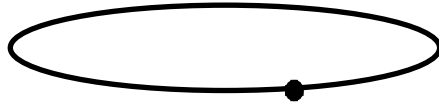
**14** The moon Io revolves around Jupiter in 0.0048 sidereal years. Io has an mean orbital radius of 0.0028 Au's. If the Jupiter moon has a period of rotation of 0.0097 sidereal years, then how far away is Europa from the center of Jupiter?

**15** The planet Mercury takes 0.24 sidereal years to go around the sun. What is the distance from the center of Mercury to the center of the sun?

**16** The moon takes 27.32 days to revolve around the Earth once. The moon is 25,201 mi from the center of the Earth. The International Space Station orbits in the same orbit as the space shuttle. The International Space Station makes an orbit around the Earth in 90 minutes, then how high up is the International Space Station from the center of the Earth <u>and</u> the surface of the Earth? (The diameter of the Earth is 3950 miles.) Why is this answer different from question #8?

**17** The Planet Jupiter's mean orbital radius is 5.2025 Au's. What is the period of Jupiter in sidereal years?

**18** The planet Pluto is 39.5 Au's from the Sun. How long does is take to go around the Sun once?

**19** Their is belt of asteroids between Mars and Jupiter. This belt circles the "inside" of our solar system and is called the Asteroid belt. This belt has a mean radius from the Sun of 2.6 Au's. how long does it take for 1 asteroid to in the belt to travel around the Sun once?
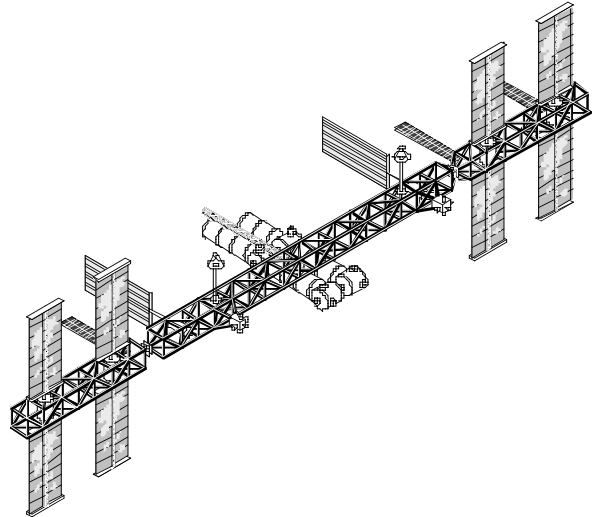
## ORBITAL VELOCITY

**20** A satelite is placed in an orbit 16,090,000 meters above the Earth's Surface. How fast is the satelite traveling to remain in orbit?

**21** A space ship is to orbit a planet wtih a mass of $8 \times 10^{20}$ kg. How far, from the plant's center, must the ship travel if it is to travel with a velocity 10,000 $m/s$?

**22** A space craft is to orbit an asteroid of mass $5.00 \times 10^{15}$ kg at a distance of 55,555 m from the asteroid's center. What is the space craft's period of motion and orbital velocity?

**23** The Hubble Telescope orbits the Earth 596,000 m ABOVE THE SURFACE of the earth. What is the Telescope's Period and tangential velocity?

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## Answers

| | | | | | |
|---|---|---|---|---|---|
| **1.** | $2.6023 \times 10^{-5}$ N | **7.** | 9 times farther away | **15.** | $5.76 \times 10^{10}$ m |
| **2.** | $9.3416 \times 10^{-7}$ N | **8.** | 54,7771.53 m (340 mi) | **16.** | 437.65 miles |
| **3.** | 5,774,945.887 m | **9.** | 1018.05 m/s | **17.** | 11.87 Au's |
| **4.** | 10.0 m | **10.** | 42255942.3 m | **18.** | 248 sidereal years |
| **5.** | 1/4 the weight, therefore 112.5 N | **11., 12., 13.,** | | **19.** | 4.192 sidereal years |
| **6.** | 60;  New =$(1/60^2)$OLD | **14.** | 0.00447 Au's | **20.** | 4979.89 m/s |

21    5, 338,072 m

22    2.451 m/s;  142,440 s

23    7563 m/s;  5795.511 s