# PH 220 Homework Assignment Chapter on Forces III – 20 Problems Total

**1.** The mass of the planet Mars is $6.39\ x\ 10^{23}\ kg$. The radius of Mars is $3.39\ x\ 10^{6}\ m$. What is the approximate acceleration due to gravity on the surface of Mars?

**Solution for Problem 1**

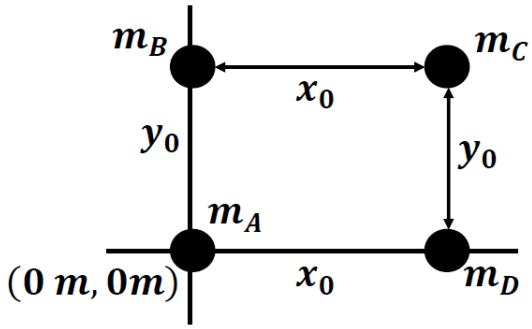
**2.** Determine the acceleration of gravity when you are near the surface of the Earth.

**(a)** At $7000.\ \mathrm{m}$ above the surface of the Earth.

**(b)** At $7000.\ \mathrm{km}$ above the surface of the Earth.

**Solution for Problem 2**

**3.** Four masses are located at the corners of a rectangle as shown below. Masses are multiples of a value $\mathrm{m}$ as given: $\mathrm{m_A} = 2\mathrm{m}, \mathrm{m_B} = 4\mathrm{m}, \mathrm{m_C} = 6\mathrm{m}, \text{and } \mathrm{m_D} = 8\mathrm{m}$. Find the total gravitational force acting on mass $\mathrm{m_A}$ at the origin in terms of $\mathrm{m}, \mathrm{x_0}, \text{and } \mathrm{y_0}$. Express the force in component notation.




**Solution for Problem 3**

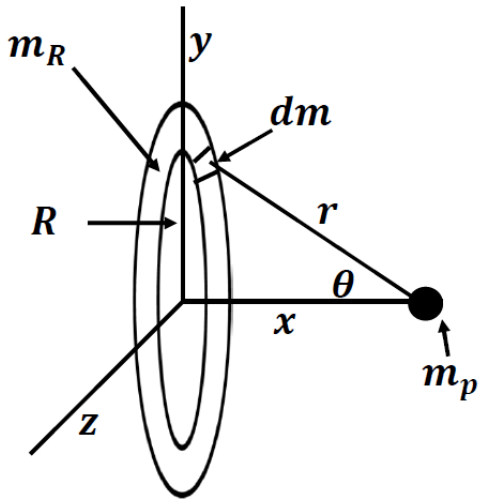
**4.** The mass of the Earth is given as $5.98\ \mathrm{x}\ 10^{24}\ \mathrm{kg}$. What would be the acceleration of gravity at the surface of a smaller object in space if it had a mass of $3.52\ \mathrm{x}\ 10^{21}\ \mathrm{kg}$, but the object has the same mass density as Earth has?

**Solution for Problem 4**

**5.** Both the Moon and the Earth exert gravitational force on any objects near them. Find the distance from the center of the Earth to a point in space along a line that connects the center of mass for the Earth and the center of mass for the Moon. At this point the gravitational force from the Earth is exactly balanced by the force of gravity from the Moon.

**Solution for Problem 5**

**6.** A ring of radius $\mathrm{R}$ and mass $\mathrm{m_R}$ is located surrounding the origin of a 3-dimensional coordinate system as shown below. A second mass $\mathrm{m_p}$ is located along the x axis a distance x from the origin. Derive and expression for the gravitational force the ring exerts on the mass point.




Hint: Consider the ring to be composed of many small masses $\mathrm{dm}$; use symmetry as you sum over all these infinitesimal mass points.

**Solution for Problem 6**

**7.** While you are standing on a weight scale which is located inside a moving elevator, the weight scale shows your mass to be $54.7\ \mathrm{kg}$. You know your mass is actually $68.3\ \mathrm{kg}$. How fast is the elevators accelerating and in which direction?

**Solution for Problem 7**

**8.** The Mars orbiter a satellite which orbits Mars at an altitude of $3.16 \times 10^5\ \mathrm{m}$ above the surface Mars helps the rovers on the surface of Mars maintain radio contact with Earth. The mass of Mars is $6.39 \times 10^{23}\ \mathrm{kg}$ and the radius of Mars is $3.40 \times 10^6\ \mathrm{m}$. What is the period of orbit for this satellite?

**Solution for Problem 8**

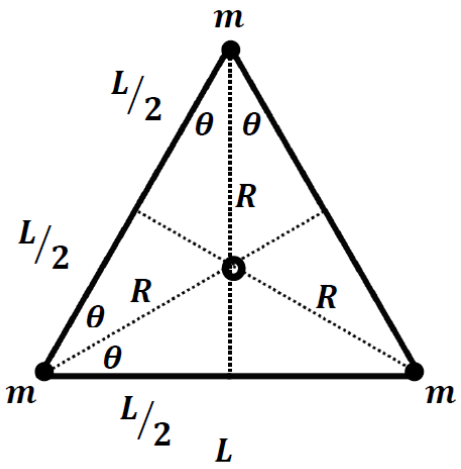
**9.** A Ferris Wheel has a radius $13.5\ \mathrm{m}$ is rotating with a period of 1 rotation per $14.3\ \mathrm{s}$. What is the ratio of a person's apparent weight to their actual weight when they are:

**(a)** At the bottom of the wheel and

**(b)** At the top of the wheel.

**Solution for Problem 9**

**10.** Three objects of identical mass $\mathrm{m}$ sit at the corners of an equilateral triangle of side length $\mathrm{L}$. The three objects rotate around their common center of mass which is the center of the triangle. They are held in place by the mutual gravitational attraction. Determine their orbital speed about the center of rotation. A sketch is provided to help set things up.




**Solution for Problem 10**

**11.** The time for the Moon to go once around its orbit of Earth is $27.3\ \mathrm{days}$. The distance from the center of the Earth to the center of the Moon is $3.84\ \mathrm{x}\ 10^{8}\ \mathrm{m}$. Use these data points to estimate the mass of the Earth.

**Solution for Problem 11**

**12.** Two planets are in circular orbits about a star. Planet 2's radius of orbit is $16$ times the radius of Planet 1's orbit. What is the ratio of the orbital speeds $\frac{v_1}{v_2}$?

**Solution for Problem 12**

**13.** Halley's comet last visited near Earth in 1986. It is due back in 2061. Halley's comet has a period of $74.7$ years.

**(a)** What is its average distance from the Sun in AU?

**(b)** When it is closest to the Sun its distance (perihelion) is $0.593$ AU. One astronomical unit $(1\ \text{AU} = 1.50\ \text{x}\ 10^{11}\text{m})$ is the average distance from the Earth to the Sun. What is its farthest distance from the Sun in AU?

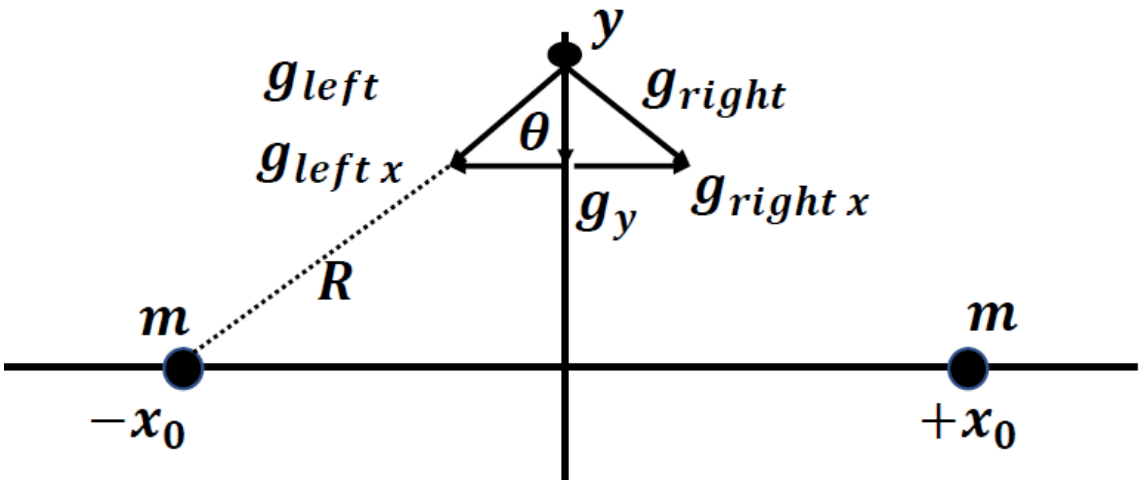
**(c)** What is the ratio of the orbital speed of Halley's Comet when it is closest to the Sun versus farthest from the Sun $^{\text{V}_{\text{close}}}/_{\text{V}_{\text{far}}}$?

**Solution for Problem 13**

**14.** What affect does the mass of the Sun have on your weight? Determine the acceleration of gravity due to the Sun at the surface of the Earth. Would this modify your actual weight?

**Solution for Problem 14**

**15.** Two identical particles of mass $\text{m}$, are located on the x axis at points $\pm\text{x}_0$.as shown below.




**(a)** Determine a formula for the gravitational field due to these two particles for points along the y axis. Express it as a function of $\text{y}, \text{m}, \text{x}_0$, and any constants needed.

**(b)** Determine where along the y axis the gravitational field will be a maximum and determine that value.
Hint: take first derivative of what you found in (a) and set it equal to zero.

**Solution for Problem 15**

**16.** For stars that have masses around the mass of our Sun, they will not undergo big supernova events and become either black holes or neutron stars. Instead they will cause their outer layers to slough off and the dense core which is mostly in an electron degenerate state will survive. The result is an object with the mass of our Sun but in a volume comparable to our planet. Consider such a white dwarf with the mass of our Sun so $\mathrm{m} = 1.99 \text{ x } 10^{30} \text{ kg}$ and a radius the same as Earth $\mathrm{R} = 6.37 \text{ x } 10^{6} \text{ m}$.

**(a)** Estimate the value of the acceleration of gravity near the surface of this white dwarf.

**(b)** Using the value found in (a) what would that make the weight of a $75.0 \text{ kg}$ person?

**(c)** What would the speed of a rock $(\mathrm{m}_{\mathrm{rock}} = 0.345 \text{ kg})$ be after falling from rest a distance of $1.25 \text{ m}$?

**Solution for Problem 16**

**17.** The Magellan spacecraft orbited Venus from 1990 to 1994. During this time, it used microwaves to map the surface of the planet through its thick opaque atmosphere. The mass of Venus is $\mathrm{m}_{\mathrm{Venus}} = 4.87 \text{ x } 10^{24} \text{ kg}$ and its radius is $\mathrm{R}_{\mathrm{Venus}} = 6.05 \text{ x } 10^{6} \text{ m}$. If the satellite took $5.44 \text{ x } 10^{3} \text{ s } (\sim 1.5 \text{ hours})$, how far above the surface of the planet was the satellite orbiting?

**Solution for Problem 17**

**18.** The Global Positioning System (GPS) uses 24 satellites orbiting the Earth. These satellites use triangulation and comparing signals transmitted by these satellites to a receiver which can then determine your exact location on Earth to within an accuracy of a few centimeters. The satellite orbits are distributed evenly around the Earth with four satellites in each of six orbits allowing continuous navigational corrections or fixes. The satellites orbit at altitudes of approximately $2.04 \text{ x } 10^{7} \text{ m}$ above the surface of the Earth. Reminder the radius of the Earth is $6.37 \text{ x } 10^{6} \text{ m}$ and the mass of the Earth is $5.98 \text{ x } 10^{24} \text{ kg}$.

**(a)** Determine the speed of each satellite.

**(b)** Determine the period of each satellite.

**Solution for Problem 18**

**19.** Our Sun is approximately $8$ kiloparsecs $(2.469 \text{ x } 10^{20} \text{ m})$ from the center of our galaxy, the Milky Way Galaxy. It takes our Sun approximately $225$ Million years $(7.097 \text{ x } 10^{15} \text{ s})$ to orbit once. From this information, what is the mass of our galaxy which lies inside of the orbit of our Sun around the galactic center? Express your in answer in terms of our Sun's mass $(1.99 \text{ x } 10^{30} \text{ kg})$.

**Solution for Problem 19**

**20.** An object is released from rest at a height $R_E$ (the radius of the Earth) above the surface of the Earth. Ignoring air resistance estimate its velocity just before it strikes Earth's surface. Hint: using Newton's Second Law and the Law of Universal Gravitation, apply a chain rule and integrate.

**Solution for Problem 20**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