PHY1014

Week 5

Read [chapter 6.5](https://openstax.org/books/college-physics/pages/6-5-newtons-universal-law-of-gravitation)

**This handout contains selected problems with**

* **step-by-step solutions**

**and**

* **the demonstration of the thinking process involved in problem-solving.**

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1. *Calculate Earth’s mass given the acceleration due to gravity at the North Pole is* *and the radius of the Earth at the pole is 6371 km. (b) Compare this with the accepted value of* *.*

# Step 1

Read the problem again and highlight the important information.

1. *Calculate Earth’s mass given the acceleration due to gravity at the North Pole is* *and the radius of the Earth at the pole is 6371 km.*
2. *Compare this with the accepted value of* *.*

Known: radius of Earth, acceleration due to gravity on Earth

Unknown: the mass of Earth

Note: all physics quantities in the problem are in SI units.

# Step 2

Decide what formula to use.

Acceleration due to gravity can be found using this formula

$g=G\frac{M}{r^{2}}$,

 $G =6.67 x 10^{-11} $Nm2/kg2 is gravitational constant

$g$ is acceleration due to gravity on a planet

$M$ is the mass of a planet

If we rearrange it for mass, then we will have

Mass of a planet

$M= \frac{Gr^{2}}{g}$,

$M$ is the mass of a planet

$g$ is acceleration due to gravity on a planet

$r$ is radius of a planet

 $G =6.67 x 10^{-11} $Nm2/kg2 is gravitational constant

# Step 3

Substitute numbers into formula and calculate.

1. 
2. This is identical to the best value to three significant figures.

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*The existence of the dwarf planet Pluto was proposed based on irregularities in Neptune’s orbit. Pluto was subsequently discovered near its predicted position. But it now appears that the discovery was fortuitous, because Pluto is small and the irregularities in Neptune’s orbit were not well known. To illustrate that Pluto has a minor effect on the orbit of Neptune compared with the closest planet to Neptune: (a) Calculate the acceleration due to gravity at Neptune due to Pluto when they are*  *apart, as they are at present. The mass of Pluto is* *. (b) Calculate the acceleration due to gravity at Neptune due to Uranus, presently about*  *apart and compare it with that due to Pluto. The mass of Uranus is* *.*

# Step 1

Read the problem again and highlight the important information.

*The existence of the dwarf planet Pluto was proposed based on irregularities in Neptune’s orbit. Pluto was subsequently discovered near its predicted position. But it now appears that the discovery was fortuitous, because Pluto is small and the irregularities in Neptune’s orbit were not well known.*

*To illustrate that Pluto has a minor effect on the orbit of Neptune compared with the closest planet to Neptune:*

*(a) Calculate the acceleration due to gravity at Neptune due to Pluto when they are*  *apart, as they are at present. The mass of Pluto is* *.*

*(b) Calculate the acceleration due to gravity at Neptune due to Uranus, presently about*  *apart and compare it with that due to Pluto.*

*The mass of Uranus is* *.*

Known:

1. mass of Pluto, distance between Neptune and Pluto
2. mass of Uranus, distance between Neptune and Uranus

Unknown: acceleration due to gravity

Note: all physics quantities in the problem are in SI units.

# Step 2

Decide what formula to use.

To calculate acceleration due to gravity, we can use this formula

$g=G\frac{M}{r^{2}}$,

 $G =6.67 x 10^{-11} $Nm2/kg2 is gravitational constant

$g$ is acceleration due to gravity on a planet

$M$ is the mass of a planet

# Step 3

Substitute numbers into formula and calculate.

(a) 

In this case $M= m\_{p}$ mass of Pluto.

(b) 

In this case $M= m\_{U}$ mass of Uranus.

The effect of Uranus on Neptune’s gravity is 20,000 times stronger than the effect of Pluto.