Physics 131-01: Physics I—Mechanics
Test 3
November 18, 2015

Name: _____

All problems *must* begin with either a fundamental principle or with an equation from the equation sheet. If any question is unclear, please ask immediately. Be sure to show your work **clearly**. Partial credit may be given for work *if* it can be understood.

Problem 1: (25 pts.) Phobos, one of the moons of Mars, has a mass of $1.08 \times 10^{16}\,\text{kg}$ and a mean radius of $13,500\,\text{m}$. (For this problem, assume that the moon is perfectly spherical.)

a. (10 pts.) Suppose an astronaut is standing on Phobos and is holding a $0.200\,\text{kg}$ ball a height of $1.00\,\text{m}$ above the surface. What force does the astronaut have to exert to hold the ball up?

b. (10 pts.) Suppose the astronaut wants to throw the ball horizontally so that it goes in a circular orbit $1.00\,\text{m}$ above the surface of Phobos. With what speed should the astronaut throw the ball?

c. (5 pts.) What is the period of the ball's orbit?

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Name: SOLUTIONS

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Problem 1: (25 pts.) Phobos, one of the moons of Mars, has a mass of 1.08×10^{16} kg and a mean radius of 13,500 m. (For this problem, assume that the moon is perfectly spherical.)

a. (10 pts.) Suppose an astronaut is standing on Phobos and is holding a 0.200 kg ball a height of 1.00 m above the surface. What force does the astronaut have to exert to hold the ball up?

$\Sigma F = 0$

$F_{astronaut} = F_{Phobos}$

$F_{astro} = \frac{GMm}{(R+1)^2} = \frac{(6.67\times10^{-11}\ N m^2/kg^2)(1.08\times10^{16}\ kg)(0.20 kg)}{(13501\ m)^2}$

$\boxed{F_{astro} = 7.90\times10^{-4}\ N}$

b. (10 pts.) Suppose the astronaut wants to throw the ball horizontally so that it goes in a circular orbit 1.00 m above the surface of Phobos. With what speed should the astronaut throw the ball?

$F = ma$

$7.90\times10^{-4}\ N = m v^2/R$

$v = \sqrt{RF/m} = \sqrt{(13501 m)(7.90\times10^{-4} N)/0.20 kg}$

$\boxed{v = 7.30\ m/s}$

c. (5 pts.) What is the period of the ball's orbit?

$T = \frac{2\pi r}{v} = \frac{2\pi(13501\ m)}{7.30\ m/s} = \boxed{11,600\ s}$