Physics 1114 - General Physics I

Final Exam - 2012.12.12

Name: _____

Instructions: Please show all work on each problem, and give full explanations where needed. No points will be awarded for a correct answer, points are awarded on the work shown for each problem. When you are finished, please attach your cheat sheet to this final exam. A list of all needed values of constants and a figure for problem 4 are located on the last page. Good luck!

problem	points	score
1	5	
2	6	
3	5	
4 (a)	5	
4 (b)	5	
4 (c)	5	
5	8	
6	10	
7	6	
8	8	
9	6	
10	6	
11	5	
12	8	
13	8	
14	6	
Total	102	

1. Life on planet Nibiru, where the Anunnaki reside, is a challenge (to say the least). The mass of Nibiru, and its radius, are given in the table at the end of this exam. What is the gravitational acceleration on Nibiru to three decimal places?

2. As the Anunnaki prepare for December 21, they wish to know how close they must get to Earth so that the gravitational force felt between the two planets is equal to one-tenth that of the gravitational force of the entire Earth. What is this distance in terms of the centers of each planets? What is the distance in terms of the surface of each planet?

3. What is the total gravitational force between Nibiru and Earth the instant before they collide?

4. The sacred orbs of Anu and Ki are worshipped by all Anunnaki on Nibiru. The sacred orbs are identical, perfectly smooth 12 meter diameter spheres, each with mass 1200 kg. Each orb is attached to heavy gauge cables of equal length, and both of these cables are attached to the same spot under the sacred bridge of the Igigu, which rises to over 30 meters above the ground. The orbs hang suspended, touching at just one point, and the angle between the two cables, at the point of attachment under the bridge, is 50°. Refer the the figure at the end of this exam.

(a) Draw a free-body diagram with both orbs and the cables included.
(b) Compute the tension in each cable.
(c) Compute the force that each orb exerts on the other.

5. The Anunnaki, in corporeal form, are excellent athletes. One such specimen throws a replica of the orb of Anu (mass 12 kg) straight up into the air. It takes 4.3 seconds for the orb replica to return to the surface of Nibiru. What was the initial velocity of the unobtanium?

6. Once every 3600 years, all Anunnaki travel to the capital city of Nibiru to observe the anniversary of the building of the temple Esagilam, which stands 1670 meters tall. The final event to celebrate this occasion consists of rolling the sacred orb of Anu down a ramp which extends from the top of the temple to its base. The solid orb rolls down the ramp without slipping, what is the final velocity of the orb when it reaches the base of the temple?

7. Referring back to problem 6, how much work was done by the planet Nibiru on the orb of Anu as it rolled down the ramp?

8. Refer back to problem 4 here. Remember that the two orbs are suspended together, and each exerts a force on the other. To roll the sacred orb of Anu down the side of the temple, it must be removed quickly from the underside of the bridge. As a result, the orb of Ki is left to swing back and forth freely. The length of the cable holding the orb of Ki is exactly 15 meters long. Compute the period of oscillation for the orb of Ki, and compute the distance traveled by the orb through one period of oscillation.

9. When the sacred orb of Anu reaches the base of the temple Esagilam, it is struck by a giant anvil. When this occurs, the orb of Anu emits a sound with frequency of 30 Hz at a sound intensity of 130 dB. If the orb has a speed of 200 m/s when it is struck, and continues at this speed, compute the perceived frequency of a stationary listener for the emitted sound in front of the orb and the perceived frequency of a stationary listener for the emitted sound behind the orb.

10. Once the sacred orb of Anu has been rolled down the side of temple Esagilam, it is of the utmost importance to join it back up with the sacred orb of Ki. To do this, the orb of Anu is raised to the underside of the Igigu bridge by a single, specially selected Annunnaki, who jumps up into the air without mechanical assistance. The Annunnaki in question weighs 156 kg, and together with the orb, pushes upward and leaves the surface with an initial speed of 78 m/s. What is the recoil speed of the planet Nibiru in response?

11. Compute the density of the orbs of Anu and Ki.

12.The cable holding orb of Ki once accidentally snapped, and the orb rolled into the great freshwater lake of Kishar, which holds 10 km^3 of water. Compute the magnitude of the upward buoyant force of water in Kishar Lake acting on the fully submerged orb (before it has hit the bottom of the lake).

13. The reason the cable holding the orb of Ki snapped was that the orb became exposed to an extreme temperature change in an experiment gone wrong. The cable became brittle after it reached a temperature of 12 K. One can assume that the temperature of the orb of Ki was at this same temperature when it dropped from the bottom side of the bridge of Esagilam. The temperature of Lake Kishar before the orb dropped into it was measured at 278 K. Soon afterwards, the lake froze solid, and at equilibrium, the lake and orb had a measured temperature of 272 K. Compute the specific heat capacity of the orb of Ki.

14. The Anunnuki known as Lahamu, in his infinite wisdom and clever ways, has devised a container which is divided into two parts. He named the two parts of his container *Abzu* and *Eridu*. Lahamu proceeds to fill both parts with the same gas at equal temperatures. Lahamu has the ability to observe the molecules on both sides, and manipulates a door between the two parts. When a faster-than-average molecule from the Abzu flies towards the door, Lahamu opens it and the molecule will fly from the Abzu to the Eridu. Similarly, when a slower-than-average molecule from the Eridu flies towards the door, the demon will let it pass from the Eridu to the Abzu. The average speed of the molecules in the Eridu will have increased, and the average speed of the molecules in the in the Abzu will have decreased. Since average molecular speed corresponds to temperature, the temperature decreases in the Abzu and increases in the Eridu. What law is Anunnuki attempting to break, and how?

planet	Nibiru	Earth
mass	2.387×10^{24} kg	5.97×10^{24} kg
radius	3.060×10^{6} m	6.38×10^{6} m
orbital period	$>$ 3600 years	365.3 days
gravitational acceleration	≈ 17 m/s^2	9.81 m/s^2
speed of sound in air	≈ 278 m/s	344 m/s

gravitational constant	$G = 6.674 \times 10^{-11}$ N $\cdot$ m^2/kg^2
density of freshwater	$\rho_{H_2O} = 1.00 \times 10^{3}$ kg/m^3
specific heat capacity of water	$c_{H_2O} = 4190$ J/(kg $\cdot$ K)
latent heat of fusion for water	$L_f = 3.34 \times 10^{5}$ J/kg

solid sphere	$I = \frac{2}{5} M R^2$
hollow sphere	$I = \frac{2}{3} M R^2$
solid cylinder	$I = \frac{1}{2} M R^2$
thin-walled hollow cylinder	$I = M R^2$

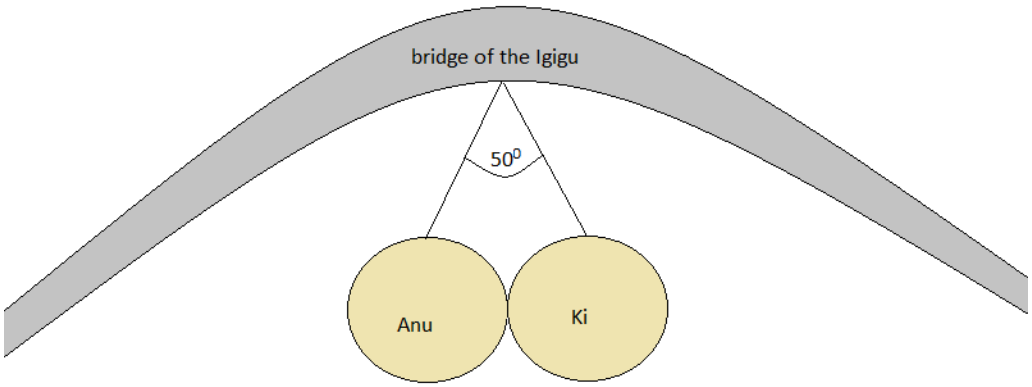

Figure to go along with problem 4.