Physics 1114 - General Physics I

Final Exam - 2012.07.27

Name: _____

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1. Your professor has obtained a sample of unobtainium, and has decided to throw it around the room. The speed of the unobtainium, in the air immediately upon release, is measured at 45.0 m/s. The professor was in contact with the unobtainium over a distance of 1.50 m and produced constant acceleration. What acceleration did he give the unobtainium, and how much time did it take to pitch it?

2. You are on the roof of the mathematics building, 12.0 m above the ground. Your awesome professor, who is 2.0 m tall, is walking alongside the building at a constant speed of 1.2 m/s. If you wish to drop a sample of unobtainium on your professor's head, where should the professor be when you release the sample? You can assume the unobtainium encounters no appreciable air drag.

3. A piece of unobtainium is accidentally thrown over the side of a cliff into a pool of water. In a frantic attempt at retrieval, a student dives off the cliff with a running horizontal leap. What must the student's speed be just as they leave the top of the cliff so that they will miss an outcropping that is 1.75 m wide and 9.00 m below the top of the cliff that they just leapt off of?

4. A student pushes a crate of unobtainium along the floor, by a force of 10 N that points downward at an angle of 42° below the horizontal. Find the horizontal and vertical components of the push.

5. Two students pull horizontally on ropes attached to a very heavy crate of unobtainium. The angle between the ropes is 60°. If student A exerts a force of 270 N and student B exerts a force of 300 N, find the magnitude of the resultant force and the angle it makes with student A's rope.

6. How many kilometers would you have to shoot a crate of unobtainium above the surface of the earth for its weight to decrease to half of what it was on the surface? Here you may assume that the radius of the earth is 6.38×10^6 m and that the mass of the earth is 5.97×10^{24} kg. The gravitational constant G has a value of 6.674210×10^{-11} $\mathrm{N{\cdot}m^2/kg^2}$.

7. Two identical masses of unobtainium traveling in opposite directions with the same speed V make a head-on collision. Find the speed of each object after the collision if (a) they stick together and (b) if the collision is perfectly elastic.

8. A car is traveling at a speed of 63 mi/h on a freeway. If its tires (made of unobtainium of course) have diameter 24.0 in and are rolling without sliding or slipping, what is their angular velocity?

9. A solid block of unobtainium, moving towards a stationary stranded student at 25.0 m/s on an unknown planet, is vibrating and emitting sound at a frequency of 1200 Hz. If the stationary student, hears a tone of 1240 Hz, what is the speed of sound in the atmosphere of this planet?

10. A solid cube 5.0 cm on each side is made of unobtainium. After you drill a cylindrical hole 2.0 cm in diameter all the way through and perpendicular to one face, you find that the cube now weighs 750 N. What is the density of unobtainium? What did the cube weigh before you drilled the hole in it?

11. You are given a sample of unobtainium to determine its specific heat. You weigh the sample and find that its weight is 3.1 N. You carefully add 1.25×10^4 J of heat energy to the sample and find that its temperature rises 10.8°C. What is unobtainium's specific heat?

12. A copper pot with a mass of 0.500 kg contains 0.170 kg of water, and both are at a temperature of 20°C. A 25.0 kg block of unobtainium at 85°C is dropped into the pot. Find the final temperature of the system, assuming no heat loss to the surroundings. You may assume that the specific heat capacity of unobtainium is $c_u = 3660$ J / kg·k. Similarly, for copper $c_c = 390$ J / kg·k and $c_w = 4190$ J / kg·k.

13. An ideal gas (vaporized unobtainium) expands while the pressure is kept constant. During this process, does heat flow into the gas or out of the gas? Justify your answer.

14. A 20.0 L tank contains 2.25 kg of vaporized unobtainium at 780°C. The molar mass of vaporized unobtainium is $M = 4.0$ kg/mol. How many moles of vaporized unobtainium are in the tank? Determine the pressure in the tank, state your answer in both pascals and atmospheres. Remember that 1 L = 1000 cm^3 and 1 atm = 1.013×10^5 Pa and $R = 8.315$ J/mol·K.