University of Mississippi Name: _____
PHYS 213 Sec 4, 5 Dec 2005

Final Exam

Read these instructions:
Answer all of the following questions. You may use a calculator, but no book or notes. You may add more sheets for the problems, if needed. Keep in mind that what you write should be a readable, well-organized and understandable explanation of how you arrive at each answer.
Questions: Explain all your answers; Do not use more than 6 lines for each question.
Problems: For each equation you use, explain why it applies. In the calculations, explain all of your assumptions; Don't include non-relevant equations and calculations.
All questions and each part of each problem are worth the same number of points.

Some numbers that may be useful:
— Atomic mass unit: $u = 1.66 \times 10^{-27}$ kg
— Universal gas constant: $R = 8.314$ J/mol·K
— Boltzmann's constant: $k = 1.38 \times 10^{-23}$ J/K.

Questions:

1. While flying in an airplane, you decide to pull out a bathroom scale, put it on the floor, and stand on it. After a while, you notice that the scale shows a weight that is 10% higher than your normal one on Earth. Supposing that the scale is functioning well, what did the airplane do that caused this? (You don't have to provide numbers in your answer, but you may.)

2. Give an example of a situation in which an object moves and a normal force does work on it, and one in which the normal force does not do any work on a moving object.

3. A bullet is shot into a block of wood that was at rest on a horizontal surface, and remains embedded in the wood; the two start moving together. Suppose you know both masses and the initial speed of the bullet, and you want to find the final speed of the moving block. For each of the following, state (i) whether it holds in this situation, and (ii) whether you could find the final speed using it:

— Newton's second law of motion:

— Conservation of mechanical energy:

— Conservation of linear momentum:

4. When you measure blood pressure, the measurement is always done on the arm at the height of the heart. Using the equations we have seen that involve pressure in fluids, explain why measuring pressure at a different level would make a difference.

5. You are listening to music from a loudspeaker, and someone says that if you moved back to twice the distance from the speaker, the music you hear would sound half as loud. Is that correct?

6. Can both transverse and longitudinal waves produce standing wave patterns? (For each type, if the answer is no, explain, if it is yes, give an example.)

Problems:

7. A hunter aims directly at a target which is at the same level, 80.0 m away. If the bullet leaves the gun with a speed of 175 m/s, by how much will he miss the target?

8. A pickup truck is driving up a 22º slope with a large crate in the back. The coefficient of static friction between the crate and the truck bed is 0.60 and that of kinetic friction 0.50. What is the maximum acceleration the truck can have before the crate starts to slide?

9. A ball at the end of a string is revolved at a uniform rate in a vertical circle of radius 68.0 cm. If its speed is 4.00 m/s and its mass is 0.250 kg, calculate the tension in the string at the point where the tension is greatest.

10. A compressed spring is used to shoot a 0.20-kg ball vertically upward. If the spring constant is 900 N/m and the spring is compressed by 12 cm before releasing the ball, how high will the ball go?

11. A figure skater is spinning at 3.5 rev/s with her arms close to her body, so you can assume that she is almost a uniform cylinder with a height of 1.6 m, radius 17 cm, and mass 60 kg. If she stretches her arms out, how fast will she spin? Assume that she is now a cylinder of the same shape but with a smaller mass by 10 kg, and her arms have a mass of 5.0 kg each and act like 65-cm long rods. (The moment of inertia for a cylinder spinning around its axis is $MR^2/2$, and that of a rod rotating around one end is $ML^2/3$.)

12. A 60-kg diver stands on the tip of a 4.5-m long diving board with a mass of 35 kg. The board is supported by a post A at the other end, and another post B at 1.0 m from the first post. Calculate the force that the two posts exert on the diving board.

13. A simple pendulum has been calibrated so that on Earth its period is 1.00 s. An astronaut takes it to the surface of the Moon, where the force of gravity is 1/6 of that on Earth. What will the period of the pendulum be, and will the fact that there is no atmosphere on the Moon affect the pendulum?

14. If you take an open, empty 2.0-L plastic bottle at room temperature (20ºC) and close it with its cap, how many moles of air will you have inside it, and how fast will the rms speed of the nitrogen molecules (N_2) inside it be? Assume that nitrogen has an atomic mass of 14.00.