University of California, Berkeley
Physics 8A Spring 2007 (*Yury Kolomensky*)

PRACTICE PROBLEMS FOR MIDTERM II

Maximum score: 100 points

You are given 120 minutes for this exam. You are allowed one $8 - 1/4'' \times 11''$ sheet containing any information you wish on both sides. Show all work, and take particular care to explain what you are doing. Write directly on the exam, and if you need extra pages, make sure to put a note on the corresponding sheet. Cross out rather than erase parts of the problem you wish the grader to ignore. Box or circle final answers.

There are five problems with points assigned as shown. Partial credit will be given for incomplete solutions, so attempt to do all problems. Some problems will take significantly longer than others, so judge time appropriately. At the beginning of the exam, please look through all problems and plan how you'll spend your time.

Note for the practice exam: this problem set is somewhat longer and more difficult than the real exam will be. As Alexander Suvorov (who never lost a battle) used to say, *"Difficult in training, easy in the battle."*

1. *(20 points)* **Road Accident**
An H2 Hummer, traveling at a speed of 80 mph and weighing 9000 lbs, collides head-on with a Wolksvagen Beetle, weight 2000 lbs, which was obeying the 65 mph speed limit. Assuming that the collision was perfectly inelastic, how much energy was transformed into heat at impact ?
Answer: $\Delta E \approx 1.5$ MJ

2. *(25 points)* **Grizzly Peak Rd**
On my daily way to Berkeley, I usually take the Grizzly Peak Road, avoiding traffic in the Caldecott Tunnel. Grizzly Peak Rd is a narrow two-lane road, with some nice hairpin turns and stunning views of the Bay (can't find a better start to a day ! But I digress). One of the turns on this road has a radius of about 10 meters.

(a) (*10 points*) Assuming the static coefficient of friction $\mu = 1$ between my tires and the pavement, what is the maximum safe speed for this turn ?

(b) (*15 points*) A motorcyclist, rounding the curve at the same speed, will have to tilt the bike into the turn to maintain balance. What angle with the horizontal does he make?

Answer: **(a)**: 10 m/s = 22 mph; (**(b)**: 45°.

3. *(20 points)* **Kid on a Carousel**
A child of mass $m = 40$ kg stands on the edge of a rotating carousel (a uniform disk, rotating around a frictionless axle) of mass $M = 80$ kg. Initially, the carousel makes one revolution every 2 sec. The child makes her way to the middle of the carousel.

(a) (*15 points*) Calculate the final rate of revolution and the factor by which the kinetic energy of rotation has been increased.

(b) (*5 points*) Where does the increase in the rotational kinetic energy come from ?

Answer: 1 Hz; 2.

4. *(15 points)* **Better Safe Than Sorry**

Before they learn how to swim, small children may use inflatable life jackets, or floaties (inflatable sleeves) to support them in water. A life jacket is supposed to support at least 15% of a child's body (head and shoulders) above water. You are writing a safety manual for a life jacket that has 1 gallon (3.8 L) volume when inflated. What is the maximum mass of a child that it can safely support ? Assume average density of a human body $\rho_h = 950\ \mathrm{kg/m^3}$.
Answer: 36 kg.

5. *(20 points)* **Municipal Water Supply**

Water pressure in the municipal water systems is usually maintained by water towers. Water tower is a large capacity water tank, elevated high above ground. You have probably seen many water towers in rural areas, where they stick out like a sore thumb (in the cities, they are often hidden on the roofs of tall buildings). A typical rural water tower could be $H = 50$ m (165 feet) high.

(a) (*10 points*) Calculate the water pressure at ground level for such a tower.

(b) (*10 points*) The water is delivered to houses through standard underground pipes of $d = 1\ \mathrm{in} = 2.54\ \mathrm{cm}$ diameter. What flow rate (volume per unit time) and water velocity could you expect in the second floor shower, 6 m above ground (if your neighbors are not using any water) ?

Answers: **(a)**: 5 atm (gauge); **(b)**: 15 L/sec, 30 m/s.