HONR268A Homework # 1 –
Due Thursday, September 22, 2005

Homeworks will be posted on the web at http://www.astro.umd.edu/~hamilton/HONR268A/. You are welcome to work together on the problems, but try them on your own first for practice, and write them up in your own words. I will try to have homeworks graded and back to you within a week.

1. Choose the make and model and year of a car and find out its price when new. Next find out its rated fuel economy in miles per gallon (mpg). Compare the cost of the vehicle to the cost of the fuel that it will use over its lifetime (assume a 150,000 mile lifetime and gas at $3 a gallon). Repeat for a second vehicle. Use your own car, a 70's station wagon, a Hummer, a limo, a motorcycle, a hybrid, or anything else that you'd like.

2. A typical human consumes about 2500 Calories a day. A Calorie is actually shorthand for 1000 calories and is a unit of energy. Convert this energy intake into Joules using the Energy handout and compare with the answer in Vaclav Smil's Energies book (Table 3, page xv). If all of this energy were available to be converted into muscle power (it isn't - some goes to heating the body, pumping blood, etc.), how many horsepower hours is this equivalent to? If an adult works continuously for 24 hours, what is his/her rate of energy expenditure in horsepower? Does your answer make sense?

3. A gallon of gasoline contains 125,000 British Thermal Units (BTUs) of energy.
a) Convert this into Joules and compare with the value for a barrel of oil in Smil (Table 2, page xv). Based on these numbers, estimate the number of gallons in a barrel of oil.
b) Now divide the energy in a gallon of gasoline by the energy consumed by a person in a day (your answer to part 2).
c) Now assume that your car gets 26 miles per gallon, that you are out of gas, and that you can push your car with the same efficiency that the engine can. How far can you push it in a day? If you hitch up a horse to your broken car, how far can he pull it in a day?

4. In June 2004, Burt Rutan's SpaceShipOne won the $10 million X Prize for reaching 100km altitude twice in a two week period. It did so by flying straight up. How much energy did this 3600kg spacecraft require to reach an altitude of 100km? To go into orbit around the Earth like the Space Shuttle does, requires reaching a speed of 7.8km/s at a similar altitude. How many times more energy would it take to put SpaceShipOne into orbit?