HONR238W Homework # 1 – All About People, Horses, and Cars
Due Monday, February 25, 2013

Homeworks will be posted on the web at http://www.astro.umd.edu/~hamilton/HONR238W/. 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 have homeworks graded and back to you within a week.

1. 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 values in the attached table. 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?

2. a) A gallon of gasoline contains 125,000 British Thermal Units (BTUs) of energy. Divide the energy in a gallon of gasoline by the energy consumed by a person in a day (your answer above). b) 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? c) If you hitch up a horse to your broken car, how far can he pull it in a day?

3. a) How much gas does it take to accelerate a 1 ton (1000kg) car from zero to 60mph = 27m/s? b) If this takes 5 seconds, what is the power output of the vehicle in Joules/s and in horsepower?

Energy, work, heat

Quantities in the colored areas are not properly energy units but are included for convenience. They arise from the relativistic mass-energy equivalence formula $E = mc^2$ and represent the energy released if a kilogram or unified atomic mass unit (u) is completely converted to energy.

	Btu	**erg**	**ft · lb**	**hp · h**	**JOULE**	**cal**	**kW · h**	**eV**	**MeV**	**kg**	**u**
1 British thermal unit =	1	1.055×10^{10}	777.9	3.929×10^{-4}	1055	252.0	2.930×10^{-4}	6.585×10^{21}	6.585×10^{15}	1.174×10^{-14}	7.070×10^{12}
1 erg =	9.481×10^{-11}	1	7.376×10^{-8}	3.725×10^{-14}	10^{-7}	2.388×10^{-8}	2.778×10^{-14}	6.242×10^{11}	6.242×10^{5}	1.113×10^{-24}	670.2
1 foot-pound =	1.285×10^{-3}	1.356×10^{7}	1	5.051×10^{-7}	1.356	0.3238	3.766×10^{-7}	8.464×10^{18}	8.464×10^{12}	1.509×10^{-17}	9.087×10^{9}
1 horsepower-hour =	2545	2.685×10^{13}	1.980×10^{6}	1	2.685×10^{6}	6.413×10^{5}	0.7457	1.676×10^{25}	1.676×10^{19}	2.988×10^{-11}	1.799×10^{16}
1 JOULE =	9.481×10^{-4}	10^{7}	0.7376	3.725×10^{-7}	1	0.2388	2.778×10^{-7}	6.242×10^{18}	6.242×10^{12}	1.113×10^{-17}	6.702×10^{9}
1 calorie =	3.969×10^{-3}	4.187×10^{7}	3.088	1.560×10^{-6}	4.187	1	1.163×10^{-6}	2.614×10^{19}	2.614×10^{13}	4.660×10^{-17}	2.806×10^{10}
1 kilowatt-hour =	3413	3.6×10^{13}	2.655×10^{6}	1.341	3.6×10^{6}	8.598×10^{5}	1	2.247×10^{25}	2.247×10^{19}	4.007×10^{-11}	2.413×10^{16}
1 electron volt =	1.519×10^{-22}	1.602×10^{-12}	1.182×10^{-19}	5.967×10^{-26}	1.602×10^{-19}	3.826×10^{-20}	4.450×10^{-26}	1	10^{-6}	1.783×10^{-36}	1.074×10^{-9}
1 million electron volts =	1.519×10^{-16}	1.602×10^{-6}	1.182×10^{-13}	5.967×10^{-20}	1.602×10^{-13}	3.826×10^{-14}	4.450×10^{-20}	10^{6}	1	1.783×10^{-30}	1.074×10^{-3}
1 kilogram =	8.521×10^{13}	8.987×10^{23}	6.629×10^{16}	3.348×10^{10}	8.987×10^{16}	2.146×10^{16}	2.497×10^{10}	5.610×10^{35}	5.610×10^{29}	1	6.022×10^{26}
1 unified atomic mass unit =	1.415×10^{-13}	1.492×10^{-3}	1.101×10^{-10}	5.559×10^{-17}	1.492×10^{-10}	3.563×10^{-11}	4.146×10^{-17}	9.32 $\times 10^{8}$	932.0	1.661×10^{-27}	1