MATH 46 WORKSHEET: Dimensional analysis

W 3/28/07

A) Consider the drag force F on a sphere of radius a, moving at speed v in fluid density ρ.

	F	a	v	ρ
M				
L				
T				

i) Fill in the matrix (if don't know dim's of F, think of Newton's (2nd Law), and decide how F depends on the other parameters: $F = \ldots$

ii) What is π, the dimensionless quantity formed from F, a, v, ρ?

iii) What linear algebra operation did you do get π?

B) Consider a pulse of energy e released at the origin at time $t=0$. The medium has heat capacity c (energy per volume per degree), and thermal conductivity K (power per length per degree). The temperature at distance r and time t is u. (Assume $u=0$ everywhere before the pulse)

	e	r	t	u	c	K
E						
L						
T						
Θ						

i) Using fundamental units energy (E), length (L), time (T) and temperature (Θ), Fill in the dimensions of the $m=6$ quantities in the problem.

ii) Find $p=2$ independent dimensionless quantities. Since there's freedom, choose π_1 to not involve u: $\pi_1 = \ldots$
π_2 to not involve r: $\pi_2 = \ldots$

iii) Pi Theorem tells us $F(\pi_1, \pi_2) = 0$ so $\pi_2 = g(\pi_1)$
From this get an expression $u = (\ldots)\, g(\ldots)$

iv) If $r=0$ how does u scale with t?

v) In general how can you get p from the linear algebra properties of the matrix?