# MATH 253

## Today

1. Finish 4.1 Determinants (Understand the definition and computation of determinants.)
2. 4.2 Properties of determinants (Understand the basic properties of determinants and what they tell us.)
3. WeBWorK

**Where is today's material used?**

1. Physics (Cross product, ?)
2. Math (change of variables in multiple integrals (Jacobian), nonsingularity of matrices, volume of a parallelepiped, Cramer's Rule, ...)

## Warm-up

Compute $\begin{vmatrix} 3 & 2 & -4 \\ 0 & 2 & 1 \\ 5 & -3 & -1 \end{vmatrix}$ (by hand).

## Proving the Theorem

**Theorem 1.** *Let $A = [a_{ij}]$ be an $n \times n$ matrix. Then*

1. $|A| = |A^t|$
2. *If $A$ has a row or column of zeros, then $|A| = 0$.*
3. $|R_i(c)A| = c|A| = |AC_j(c)|$.
4. $|cA| = c^n|A|$.
5. $|\ A_1\ \ldots\ A_{k-1}\ \ A_k + B_k\ \ A_{k+1}\ \ldots\ A_n\ | =$
   $|\ A_1\ \ldots\ A_{k-1}\ \ A_k\ \ A_{k+1}\ \ldots\ A_n\ | + |\ A_1\ \ldots\ A_{k-1}\ \ B_k\ \ A_{k+1}\ \ldots\ A_n\ |$.
6. *If one row of $A$ is a multiple of another, then $|A| = 0$.*
7. $|R_{ik}(c)A| = |A| = |AC_{ki}(a)|$.

# Next Time

1. 4.3 Cramer's Rule
2. Note: 2 proofs due Monday, 2 proofs due Wednesday.