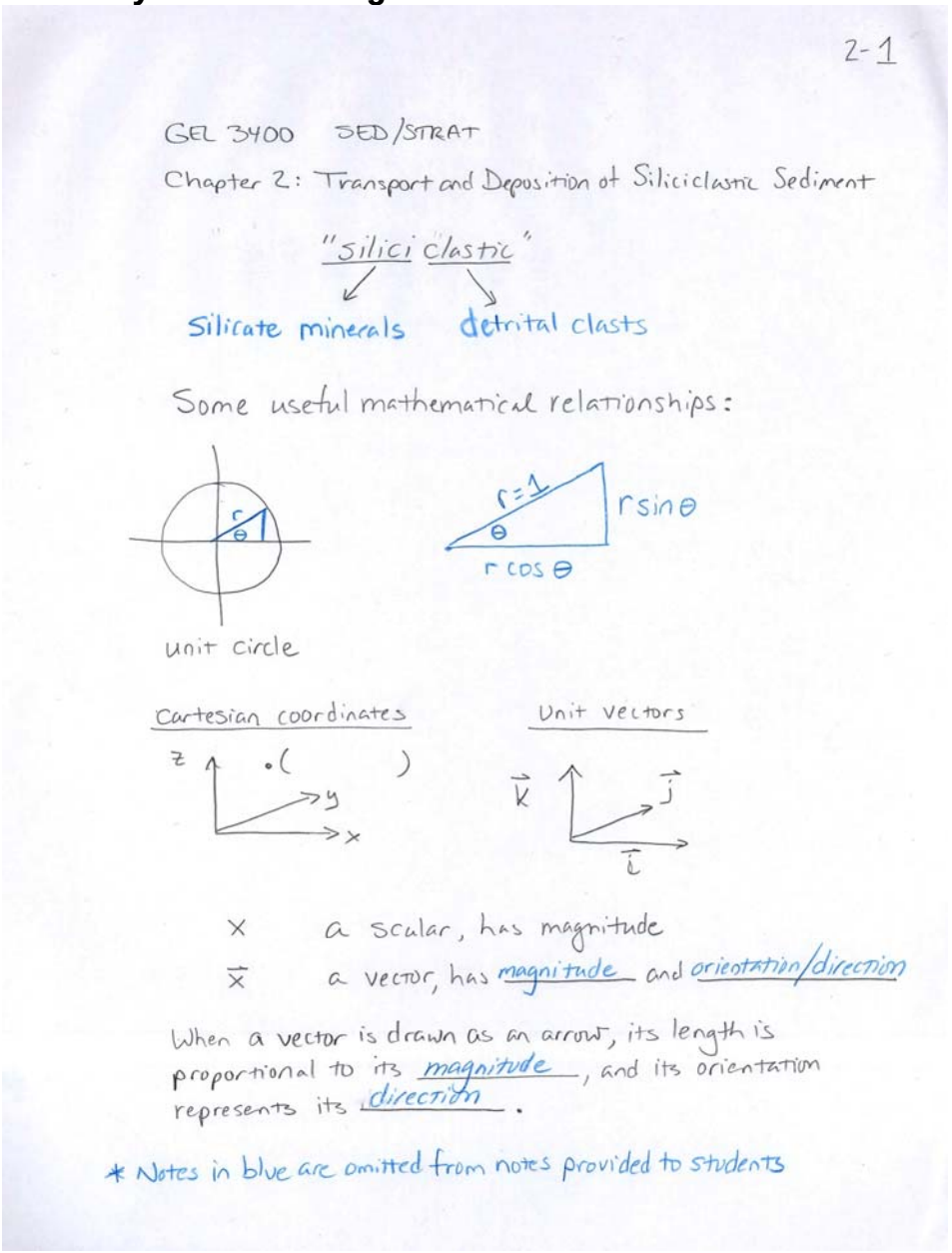
Example 1: Vectors and Coordinate Systems – Surgical Strike

These notes outline a 'surgical strike' discussion of basic trig functions related to unit circles, coordinate systems, vectors, force and stress. I use it at the beginning of a multi-lecture series that develops concepts and equations related to the transport and deposition of clastic sediment.



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GEL 3400 SED/STRAT

Chapter 2: Transport and Deposition of Siliciclastic Sediment

"silici clastic"

Silicate minerals detrital clasts

Some useful mathematical relationships:

unit circle

Cartesian coordinates

Unit vectors

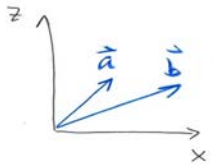
x a scalar, has magnitude

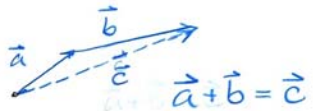
$\vec{x}$ a vector, has magnitude and orientation/direction

When a vector is drawn as an arrow, its length is proportional to its magnitude, and its orientation represents its direction.

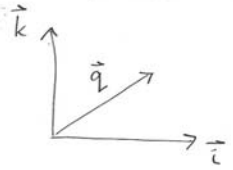
* Notes in blue are omitted from notes provided to students

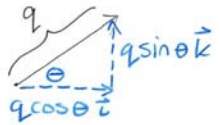
Vectors are additive: head to tail method





Vectors can be resolved into their components that are parallel to cartesian coordinates using unit vectors





$q\cos\theta\,\vec{i} + q\sin\theta\,\vec{k} = \vec{q}$

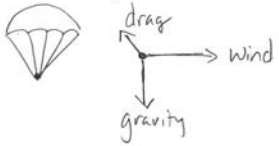
Force — Newton's Second Law

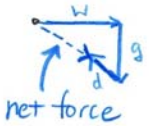
$F = m \cdot a \Rightarrow a = \frac{F}{m}$ $\quad g = 9.8\ m/s^2$

Units of force: (Newtons) $F = kg\,\frac{m}{s^2} = N$

UNIT ANALYSIS $\frac{ML}{T^2}$

Forces acting on a body can be expressed as vectors



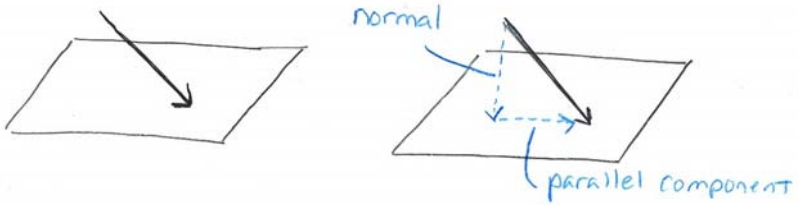


$\text{Stress} = \frac{\text{Force}}{\text{Area}}$

UNIT ANALYSIS: $\frac{\text{Force}}{\text{Area}} = \frac{N}{\text{Area}} = \frac{kg \cdot m/s^2}{m^2} = \frac{kg}{ms^2} = \frac{M}{LT^2}$

Hydrostatic forces act normal to body surfaces

Applied forces, including hydrodynamic forces, can have components normal to, and parallel to body surfaces



σ ("Sigma") = Normal Stress = $\perp$ to surface

τ ("Tau") = Shear Stress = $\parallel$ to surface