Euclidean Physics Crib Sheet

Section 2.6 Newtonian gravitation and fluid dynamics

$0 = \Delta E = K + U \Rightarrow \Delta U = -\Delta K$

2.6-1 $\int_A^x F\,dx = -U(x)$ *and* $F(x) = -\frac{d}{dx}U(x)$ U is **force potential**

2.6-2 $\int_A^x a\,dx = -V$ and $a = -\frac{dV}{dx}$ where $a = \frac{F}{m}$. V is **aceleration potential**

2.6-3. $\frac{d^2 x^i}{dt^2} = -\partial_i V$ or $\boldsymbol{a} = -\nabla V$ Eq of motion of particle in a gravitational field

2.6-4 $\Phi = \iint_S \boldsymbol{F} \cdot d\boldsymbol{A}$ where $\boldsymbol{F} = \rho \boldsymbol{v}$. General form for a **flux Integral**

2.6-5 $F = \frac{G M m}{r^2}$ **Newton's equation for universal gravitation**

2.6-9 $\nabla \cdot \boldsymbol{a} = -4\pi G\rho$ where $\boldsymbol{a}$ is an acceleration field

2.6-10 $\boldsymbol{a} = -\nabla V$ An acceleration $\boldsymbol{a}$ has a **gravitational potential** V

2.6-11 $\boxed{\nabla^2 V = 4\pi G\rho}$ **Poisson's equation**

Flow of fluid partifcles:

2.6-12 $\frac{\partial \rho}{\partial t} + \nabla \cdot (\rho \boldsymbol{v}) = 0$ **Continuity equation for a perfect fluid**

2.6-13 $\rho \frac{d\boldsymbol{v}}{dt} = -\nabla P$ **Newton's 2nd law** (for a fluid) (i.e., $m\,a = F$)

Flow of fluid at a point:

2.6-15 $\rho \left[\frac{\partial \mathbf{v}}{\partial t} + (\boldsymbol{v} \cdot \nabla)\,\boldsymbol{v}\right] = -\nabla P$ **Euler's eq of motion for a perfect fluid**