3

Classical Mechanics 3

3.1 Stokes' law

Stokes' law gives the frictional (or drag) force exerted on spherical objects with very small Reynold's numbers in a viscous fluid. The Reynold's number tells us if the fluid flow is turbulent or laminar (sheet-like). A high Reynold's number implies the fluid flow is turbulent. A low Reynold's number implies the fluid flow is laminar. The drag force is directly proportional to v^2 for turbulent flow and directly proportional to v for laminar flow. Stokes' law states that

$$F_{\mathrm{D}} = 6\pi\eta r v, \tag{3.1}$$

where η is the viscosity of the fluid, r is the radius of the sphere and v is the fluid flow velocity relative to the object.

3.2 Work done and the work-energy theorem

Work done is the transfer of energy from one place to another, or from one form to another. The work done by a constant force of magnitude F on a point that moves a displacement s is

$$W = \mathbf{F} \cdot \mathbf{s}. \tag{3.2}$$

If the force is not constant (i.e., you are given an equation for the force), you must use the integral form

$$W = \int_a^b \mathbf{F}(\mathbf{s}) \cdot d\mathbf{s}. \tag{3.3}$$

The work-energy theorem states that the work done by the sum of all forces acting on a system is equal to the change in kinetic energy of the system. For a particle of mass m moving with an initial velocity v_i and, after the application of some forces F, moves with a final velocity v_f, the work done on the particle is

$$W = \Delta T = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2. \tag{3.4}$$

In 3D...

a) the work done is $\mathbf{F} \times \mathbf{s}$	b) equation (3.4) holds for non-conservative forces
c) the total mechanical energy is always conserved	d) the work done is always $-\Delta U$
