Lecture 20, Oct 28, 2021

Calculating Work

- For a single particle not subject to potential energy change, $\Delta E = W$ and $\Delta E = \Delta K \implies W = \Delta E$
- $v_f = v_i + a\Delta t$ and $\Delta x = v_i\Delta t + \frac{1}{2}a\Delta t^2$, so
$$\begin{aligned} W &= \Delta K \\ &= K_f - K_i \\ &= \frac{1}{2}m(v_f^2 - v_i^2) \\ &= \frac{1}{2}m((v_i + a\Delta t)^2 - v_i^2) \\ &= \frac{1}{2}m(2v_i a\Delta t + a^2\Delta t^2) \\ &= ma(v_i\Delta t + \frac{1}{2}a\Delta t^2) \\ &= ma\Delta x \\ &= F\Delta x \end{aligned}$$
- So work is equal to the product of the force and the displacement of the point the force acts on
- For more than one force $W = \Delta x \sum F_x$
- A closed system has $W = 0$
- There is a parallel between work and impulse; work is to energy as impulse is to momentum
- Problems can be solved in two ways: by considering everything in the system and making it a closed system (chapter 5, energy conservation based approach), or only include some parts and make some forces external (work based approach)

Multiparticle Systems

- For a multiparticle system some work goes into internal energy, so while ΔK is the applied force times to the displacement of the centre of mass, this is not quite W
- However, all work ends up somewhere, so $W_{env} = -W_{sys}$ and we can use the work done by the environment to find the work done on the system
- If there are multiple forces, the force displacement of each point might not all be equal, so $W = \sum F_i\Delta x_i$

Changing Forces

- If the force is varying then an integral can be used