

Caltech – Ph106a – Fall 2001

Problem Set 1

due 10-17-2001

Here and in future problem sets, H&F will denote problems taken from Hand and Finch's *Analytical Mechanics*.

1. Formal properties of lagrangians:

- (a) H&F 1-6 (total derivatives can be added to L).
- (b) H&F 1-8 (V with a scaling symmetry).

2. H&F 1-10 (bead on an arbitrary wire).

3. H&F 1-18 (flyball governor).

4. H&F 1-21 (driven simple pendulum).

5. **Optional challenge problem**

- (a) H&F 1-14 (L for a charged particle).
- (b) Extend the previous part by showing how one should modify the lagrangian to include an electrostatic potential. There is a gauge freedom to alter $\vec{A} \rightarrow \vec{A} + \nabla\lambda$ and $\Phi \rightarrow \Phi - \partial\lambda/\partial t$, for any function λ of position and time. Demonstrate that gauge transformations lead to physically equivalent lagrangians, and that the equations of motion are

$$m\vec{a} = e(\vec{E} + \vec{v} \times \vec{B}).$$