The University of Alabama at Birmingham (UAB)
Department of Physics

PH 461/561 – Classical Mechanics I – Fall 2005

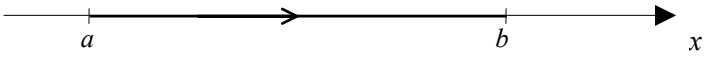
Assignment # 3 Due: **Thursday, September 1**
(Turn in for credit!)

Activities based on previous lecture:

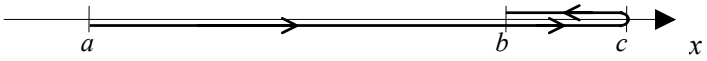
1. A particle of mass *m* moves in one dimension under a force $F(x) = \gamma x$, where γ is a positive constant (i.e., a force linear on the position *x*).

   Calculate the work done by this force in the three different situations below.

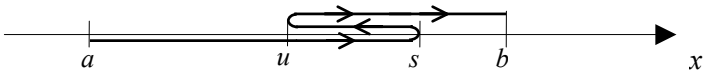
   a. When particle moves in configuration space from point *a* to point *b* according to the following orbit:



   b. When particle moves in configuration space from point *a* to point *b* according to the following orbit:



   c. When particle moves in configuration space from point *a* to point *b* according to the following orbit:

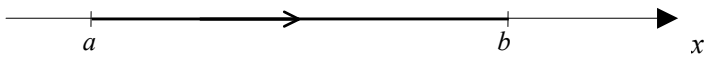


   d. Compare the values you found for the work in situations (a), (b), (c) and discuss the meaning of your finding.

2. A particle of mass *m* moves in one dimension under a force $F(v) = -\alpha v$, where α is a positive constant and *v* is the particle velocity. Assume that at point *x*=*a* the particle has an initial velocity v_0, and that $b \le a + \frac{mv_0}{\alpha}$.

   Calculate the work done by this force in the three different situations below.

   a. Calculate the work done by this force when the particle moves in configuration space from point *a* to point *b* according to the following orbit:



   b. Discuss the physical meaning of the result you found for the work in part (a). Your discussion should focus on the following aspects:

      i. Showing that the work done by *F(v)* does NOT depend only on the end points *a* and *b*.

      ii. Showing that the work done by *F(v)* depends on *how* the particle moves from *a* to *b* (i.e., the work depends on the *history*, on the details of the orbit in configuration space, on the details of the path in one dimension, etc.).

   c. Explain what happens with the work done by *F(v)* in the following limiting cases:

      i. When $b = a$. What is the physical meaning of this situation?

      ii. When $b = a + \frac{mv_0}{\alpha}$. What is the physical meaning of this situation?

3. (20 pts) A particle of mass m moves in one dimension under the force:

$$F(x) = 4\,c\,(x^3 - x) \qquad \text{where } c > 0$$

a) Discuss the effect of this force on the total mechanical energy of the particle. Is it appropriate to define a potential energy for the motion of this particle? Why?

b) Find an expression for the potential energy $V(x)$ of the particle (Choose a reference point such that any arbitrary constants vanish)

c) Draw by hand a sketch of the potential energy $V(x)$ (No computer use upfront, please!) *(You may check with a computer afterwards)*

d) For which values of the total energy will the motion be:
-Bound (i.e., confined). Find the turning points.
-Unbound, with change of direction. Find the turning points.
-Unbound, with no change of direction.

4. Fowles & Cassiday (7^{th} Edition) Problem **2.6.**

5. Fowles & Cassiday (7^{th} Edition) Problem **2.7.**

6. Fowles & Cassiday (7^{th} Edition) Problem **2.8.**