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

PH 461/561 – Classical Mechanics I – Fall 2005

Assignment # 1 Due: **Tuesday, August 23, in class.**
(Turn in for credit)

Activities based on previous lecture:

1. Read sections **2.1** & **2.2** in textbook and write a 1-page summary of what you have learned.

2. Work examples **2.1.1**; **2.1.2**; **2.2.1**

3. Based on textbook sections 2.1 & 2.2 and the section of Galileo's "Dialogue" attached, answer the following questions:

    a. Discuss at least three reasons why Newton's predecessors had difficulty arriving at the three laws of motion that Newton formulated in the *Principia* in 1687. Provide examples.

    b. What is an inertial frame of reference?

    c. Under what circumstances can planet Earth be considered an inertial frame of reference?

    d. In practice how does one decide whether a frame of reference is inertial?

    e. What is the configuration space?

4. Fowles & Cassiday (7^{th} Edition) Problem **2.1.**

5. Fowles & Cassiday (7^{th} Edition) Problem **2.2.**

Activities in preparation for *upcoming* lecture:

6. Study section **2.3** in textbook (summary not required).

7. Derive the Work-Energy Theorem: $\int_{t_0}^{t} F\left(x,v,t\right)vdt = T - T_0$

8. A particle of mass m is released from a height h near the surface of the Earth. Assume that the only force acting on the particle is the force of gravity of intensity $F=mg$. Use the Work-Energy Theorem to find the speed of the particle when it hits the ground (i.e., the particle final speed).

9. A particle of mass m is released from a great height h above the surface of the Earth. Assume that the only force acting on the particle is the force of gravity of intensity $F = -\frac{GMm}{x^2}$ where x is the distance of the particle from the center of the Earth. Use the Work-Energy Theorem to find the speed of the particle when it hits the ground.

10. On a single graph plot the functions obtained for the final speed of the particle as a function of the height it is released. Discuss any differences you may see, particularly with respect to the height of release.

11. Find an expression for the potential energy associated with following forces:

    a. $F = mg$

    b. $F = -\frac{GMm}{x^2}$

12. Fowles & Cassiday (7^{th} Edition) Problem **2.3.**

From:
"Dialogue Concerning the Two Chief World Systems – Ptolemaic and Copernican"
Galileo Galilei, Florence 1632.

Condensed version available at:
http://webexhibits.org/calendars/year-text-Galileo.html

Characters in the discussion:

- Filippo **Salviati:** Committed Copernican
- Gianfrancesco Sagredo: Open-minded Venetian, initially neutral with respect to the theories under discussion
- ***Simplicio:*** Aristotelian (Defender of the Ptolemaic Theory)

Somewhere along the discussions of The Second Day…

Salviati: …Now tell me: Suppose you have a plane surface as smooth as a mirror and made of some hard material like steel. This is not parallel to the horizon, but somewhat inclined, and upon it you have placed a ball which is perfectly spherical and of some hard and heavy material like bronze. What do you believe this will do when released? …
…
Simplicio: I do not believe that it would stay still at all, rather, I am sure that it would spontaneously roll down.
…
Salviati: … Now how long would the ball continue to roll, and how fast? Remember that I said a perfectly round ball and a highly polished surface, in order to remove all external and accidental impediments. Similarly I want you to take away any impediment of the air caused by its resistance to separation, and all other accidental obstacles, if there are any.

Simplicio: I completely understood you, and to your question I reply that the ball would continue to move indefinitely, as far as the slope of the surface extended, and with a continually accelerated motion. For such is the nature of heavy bodies… and the greater the slope, the greater it would be the velocity.

Salviati: But if one wanted the ball to move upward on this same surface, do you think it would go?

Simplicio: Not spontaneously, no; but drawn or thrown forcibly, it would.

Salviati: And if it were thrust along with some impetus impressed forcibly upon it, what would its motion be, and how great?

Simplicio: The motion would constantly slow down and be retarded, being contrary to nature, and would be of longer or shorter duration according to the greater or lesser impulse and the lesser or greater slope upward.

Salviati: Very well; up to this point you have explained to me the events of motion upon two different planes. On the downward inclined plane, the heavy moving body spontaneously descends and continually accelerates, and to keep it at rest requires use of force. On the upward slope, force is needed to thrust it along or even to hold it still, and motion, which is impressed upon it continually diminishes until it is entirely annihilated. You say also that a difference in the two instances arises from the greater or lesser upward or downward slope of the plane, so that from a greater slope downward there follows a greater speed, while on the contrary upon the upward slope a given movable body thrown with a given force moves farther according as the slope is less.

Now tell me what would happen to the same movable body placed upon a surface with no slope upward or downward.

Simplicio: Here I must think a moment about my reply. There being no downward slope, there can be no natural tendency toward motion; and there being no upward slope, there can be no resistance to being moved, so there would be an indifference between the propensity and the resistance to motion. Therefore it seems to me that it ought naturally to remain stable. But I forgot; it was not so very long ago that Sagredo gave me to understand that that is what would happen.

Salviati: I believe it would do so if one set the ball down firmly. But what would happen if it were given an impetus in any direction?

Simplicio: It must follow that it would move in that direction.

Salviati: But with what sort of movement? One continually accelerated, as on the downward plane, or increasingly retarded as on the upward one?

Simplicio: I cannot see any cause for acceleration or deceleration, there being no slope upward or downward.

Salviati: Exactly so. But if there is no cause for the ball's retardation, there ought to be still less for its coming to rest; so how far would you have the ball continue to move?

Simplicio: As far as the extension of the surface continued without rising or falling.

Salviati: Then if such a space were unbounded, the motion on it would likewise be boundless? That is, perpetual?

Simplicio: It seems so to me, if the movable body were of durable material.