Physics of Sports

Homewood Campus, JHU Hodson Hall 213
Muhammad Ali Yousuf (mali@jhu.edu)
Assignment 1

Assigned date: January 9th, 2018. Due date: January 16th, 2018

Your name: _____

Part 1

Instructions for Part `\1:

I. Since time is limited and problems may be open-ended, you are allowed to discuss with others. But please submit your own solutions for grading.
II. All problems marked "[LISA]" have been taken from: Lisa, Michael. The Physics of Sports. McGraw-Hill Higher Education, 20150220. VitalBook file.
III. Many problems don't have a right or wrong answer, just estimates. So don't worry if your answers don't match.

1. Choose the slowest among the following speeds [LISA]:
(a) 220 ft/s
(b) 100 mph
(c) 70 m/s
(d) 300 km/hr
(e) 70 yd/s

2. In physics, Hooke's Law describes the force F exerted by a spring when it is stretched a distance x. Force is measured in Newtons (N), and distance is measured in meters (m). For a spring with "spring constant" k = 10 N/m, which of the following formulas are definitely wrong, based solely on the units involved? [LISA]
(a) $F = kx$
(b) $F = kx^2$
(c) $F = x/k$
(d) $F = x^2/k$
(e) $F = kx/2$
(f) $F = kx^2/2$
(g) $F = k\sqrt{x}$

3. Write 4,000,000,000 in Scientific notation

_____

4. Write 0.000000000005 in Scientific notation

_____

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5. What is the typical height of a **male** American in centimeters, inches and foot (do some internet research)?

_____, _____, _____

6. What is the typical height of a **female** American in centimeters, inches and foot (do some internet research)?

_____, _____, _____

7. What is the weight of a typical male sportsperson of your choice?

_____

8. What is the weight of a typical female sportsperson of your choice?

_____

9. It is difficult to define average running speed of humans without referring to any specific marathon, etc. Hence answers can vary widely. But what is the typical average running speed of a **female** in mph and km/h?

_____, and _____

10. What is the typical average running speed of a **male** in mph and km/h?

_____, and _____

12. What is acceleration due to gravity in m/s^2 and ft/s^2? (decide number of decimals yourself!)

_____, and _____

11. What are the four kinematic equations?

(a) _____

(b) _____

(c) _____

(d) _____

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12. Baseball players report that pitches are faster in Denver due to the lower air density there. But can drag really be a noticeable effect for such a short flight? Later in the course we will be discussing the effects of air, but let's get a feel for these effects right now. Consider a 95-mph fastball thrown at 60 ft 6 in. from mound to plate. Don't worry about the vertical motion of the ball—we just care about horizontal.

(a) If the ball travels at constant velocity, how long does it take to reach the plate?

(b) Air drag tends to "decelerate" the ball at about 32 ft/s2 (or 9.8 m/s2), which is (rather coincidentally) 1 g. If we account for drag, how long does the ball's journey take?

(c) To get a feeling of whether air drag really matters, compare the difference between your answers to (a) and (b) with the time a bat takes to cross the plate. Is the difference between your answers to (a) and (b) much larger than this time, much smaller than this time, about the same? To answer this question, you need to know that the bat is typically moving at about 70 mph as it crosses the plate and that the plate is about 1 ft long.[Lisa]

13. We will study aerodynamic forces later in the course but you already know that air drag will slow a table tennis ball speeding through the air. Professionals like Jörgen Persson and fellow Swede Jan-Ove Waldner have had some epic matches. In one, Persson smashed a ball at 47 mph at his edge of the table. By the time it had crossed to the other side of the 9-ft table, it had slowed to 40 mph.

(a) In g's, what was the acceleration of the ball due to drag?

(b) How long did the ball take to cross the table?

(c) How does your answer in (b) compare to typical human reaction time?

(d) How much time was added due to the air drag? That is, how much more quickly would the ball have crossed the table if it had continued at 47 mph on its entire trip?

(e) In order to have enough time to react, Walder was not standing at the edge of the table, but 15 ft behind it. Assuming the same acceleration as you found in (a), how long does it take the ball to reach him, once Persson hits it?

(f) Make motion graphics: sketch the velocity and position of the ball as a function of time.
[Lisa]

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Part 2: Open ended

Objective: The objective of this part is to collect numbers which can allow you to make quick estimates later in the course and beyond. This will be in addition to general numbers you will collect in part 1.

Instructions: Chose a sport of your interest and collect all the statistics about the sport. **Provide references for each piece of information. I don't expect more than one page of data.** For example, if baseball is your passion: What is the size and weight of a baseball bat? What is the size and weight of a baseball? What is the shape/size of the field? What is the height of your favorite player, if any? If you don't have one, what is the height of the most famous player? What is the air pressure inside the ball? etc. Data like how many players play the game has little to do with the physics of the sport and hence is not required.

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Part 3: Optional Section (Not graded but responses greatly appreciated. You can answer some questions and leave others empty, if you want)

The purpose of this section is to judge your interest, and to see how to modify future versions of this course.

1. Why are you taking this course (check all that apply)?
   a. The title of the course appeared interesting
   b. I like physics, no matter in which form
   c. I needed one extra credit and this was one of the few options available
   d. I had nothing else to do during this time so decide to sleep in this classroom
   e. I love sports and thought it would be interesting to dig a little deeper

2. Do you think you'd have taken this course with greater enthusiasm if it were of:
   a. Two credits?
   b. Three credits?
   c. Four credits?

3. Have you ever thought of doing research in the field of "Physics of Sports" or "Engineering of Sports," etc.?
   a. Yes
   b. No

4. If offered the possibility of doing a directed research during summer, will be you be interested?
   c. Yes
   d. No