Department of Physics
University of Maryland
College Park, Maryland

PHYSICS 121 — Prof. S. J. Gates
Fall 2002 — Exam I — Oct. 4, 2002

This is a closed book and no notes examination. Read the entire examination before you begin to work. Be sure to read each problem carefully. Any questions should be directed to the proctors. There is a fifty minute time limit. Show all of your work. Use the backs of pages if necessary or request an extra booklet. Be sure to complete the front page of the examination booklet including your name and recitation section. Show all calculations needed to support your answers, where necessary.

Section I. Multiple Choice Questions

Each question in this section is worth eight (8) points. You should **NOT** take more than two minutes per question. If you do, it is advisable to continue on to the next question!

(1.) A ball is rolling along the x-axis with an initial velocity of $-80\,\frac{m}{s}$ and also possesses a constant uniform acceleration of $-16\,\frac{m}{s^2}$. The ball is; (a.) speeding up. (b.) slowing down. (c.) moving at a constant speed (d.) none of the above.

(2.) The addition of a vector plus a scalar; (a.) depends of the choice of coordinate system. (b.) is always very complicated. (c.) requires the introduction of a reference frame. (d.) none of the above.

(3.) If a ball is thrown with a speed of $16\,\frac{m}{s}$ at 60^o with respect to the horizontal, the speed of the ball at the top of its arc is; (a.) $16\,\frac{m}{s}$. (b.) $8\,\frac{m}{s}$. (c.) $9.8\,\frac{m}{s^2}$. (d.) none of the above.

(4.) The mass of Jupiter is 314.5 times that of earth. The radius of Jupiter is 11.31 that of earth. The acceleration of gravity at Jupiter's surface is given by; (a.) $(314.5)\,(9.8\,\frac{m}{s^2})$. (b.) $(\frac{1}{11.31})\,(9.8\,\frac{m}{s^2})$ (c.) $(2.46)\,(9.8\,\frac{m}{s^2})$ (d.) none of the above.

(5.) If the components of a vector are both positive numbers in one reference frame, then in another reference frame they (a.) cannot both be negative numbers. (b.) cannot both be positive numbers. (c.) cannot have one be a positive and the other a negative number. (d.) none of the above.

Section III. Analytical Questions

Problem (1.)

A bug is located at $(1m, 2m)$ at $t = 0s$. The same bug is observed to be located at $(2m, -3m)$) at $t = 3s$. Finally it is observed to be located at $(-3m, -1m)$ at $t = 3.5s$.

(a.) Find the average velocity between $t = 0s$ and $t = 3s$, (3 points).

(b.) Find the average velocity between $t = 3s$ and $t = 3.5s$, (3 points).

(c.) Find the average acceleration between $t = 3s$ and $t = 3.5s$, (4 points).

Problem (2.)

Two drivers decide to have a drag race. The first car is located at $45m$ behind the second car at $t = 0s$. Both cars start from rest. However, the first car can accelerate at $0.6g$ and the second car can only accelerate at $0.3g$.

(a.) If there is a tie at the end of the race, how fast is each car travelling as it crosses the finish line? (10 points)

Problem (3.)

You are told there is quarterback who throws a ball such that the y-component of the velocity is 196 $\frac{m}{s}$. The ball is thrown such that it leaves his hand at an angle of 57^o as measured from the vertical.

(a.) When does the ball reach its maximum height and do you believe the story? (10 points).

Problem (4.)

A traveller walks $3m$ south, the $4m$ west, $10m$ north, $2m$ west, $8m$ north and finally $2m$ east.

(a.) Find the components of the resulting displacement vector and the angle that it makes with the y-axis (10 points).

Hint: The y-axis points north.

Problem (5.)

We will assume that the strings and pulleys are massless.

(a.) Draw a force diagram for each mass and for the point where the strings are tied together.

(b.) Assume that $\mu = \mu_s = \mu_k$ and find the coefficient of friction such that the system is in equilibrium.

(c.) Find the tensions in each string.

Problem (6.)

The diameter of the Moon is $3.48 \times 10^6\ m$. If you stand still on the equator of the moon and wait one day, the Moon will carry you around in a complete circle. (Hint: The length of the lunar day is the same as the time it takes for the moon to complete one orbit around the earth. This time and the moon's acceleration of gravity were both given in a lecture.)

(a.) How long would a day be if the uniform circular acceleration you experience by standing on the moon's equator were equal to the acceleration of gravity on the moon's surface? (10 points)