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PHYSICS 121 — Prof. S. J. Gates
Fall 2002 — Exam II — Nov. 8, 2002

This is a closed book 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. *ALL* work should be written within the examination booklet provided. 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 child rides on a merry-go-round that completes one revolution every four seconds. She sits at a radius of 4 $m$ from the center of the ride. Her centripetal acceleration is; (a.) 9.87 $\frac{m}{s}$. (b.) 6.21 $\frac{m}{s}$. (c.) 3.14 $\frac{m}{s}$. (d.) none of the above.

(2.) Two identical blocks ($m = 5\ kg$) start from rest from different heights and slide down a frictionless inclined plane that makes an angle of $30^o$ with respect to the horizontal. At the bottom of the incline the speed of the first is measured to be 2 $\frac{m}{s}$ and the other's speed is 6 $\frac{m}{s}$ at the bottom of the incline. The height of the first is; (a.) three times that of the second. (b.) nine times that of the second. (c.) 15 times that of the second. (d.) none of the above.

(3.) Two masses ($m_1 = 3\ kg$ and $m_2 = 27\ kg$) at rest have the same amount of work done on them by a force $F$. The final velocity of the first mass is: (a.) the same as the final velocity of the second mass. (b.) is three times the final velocity of the second mass. (c.) is nine times the final velocity of the second mass. (d.) none of the above.

(4.) A wheel with an initial angular velocity of $2\pi\ \frac{\text{rad}}{s}$ begins to uniformly accelerate until its angular velocity reaches $4\pi\ \frac{\text{rad}}{s}$ . It completes three revolutions during this period. It reaches an angular speed of $4\ \pi\ \frac{\text{rad}}{s}$

after; (a.) 3 $s$. (b.) 2 $s$. (c.) 1 $s$. (d.) none of the above.

(5.) Two cars are headed directly toward each other. The first has a mass of 2000 $kg$ with a speed of 6 $\frac{m}{s}$ and the other has a mass of 4000 $kg$ with a speed of 3 $\frac{m}{s}$. A collision last 0.12 $s$ and afterward they are stuck together. The power deliver to the first car was; (a.) 600,000 Watts. (b.) 12,000 Watts. (c.) 36,000 Watts. (d.) none of the above.

## Section II. Analytical Questions

### Problem (1.)

A massless empty bucket is being filled with water starting at $t = 0$. At that same instant, a force $F = 36\ \frac{N}{s^3}\, t^3$ is applied to the bucket causing it to accelerate along the $x$-axis. While it accelerates, it continues to fill. The bucket can only hold 16 $kg$ when full.

(a.) If the acceleration of the bucket is measured to be $9\frac{m}{s^4}\, t^2$, how long does it take to fill it? (10 points).

### Problem (2.)

Before a collision, one ball of mass 10 $kg$ is rolling in the positive $x$-direction with a speed of 7 $\frac{m}{s}$. A second ball with a mass of 5 $kg$ is rolling in the positive $y$-direction with a speed of 14 $\frac{m}{s}$. After the collision, the two stick together.

(a.) What is the angle of motion for the two joined balls after the collision? (5 points).

### Problem (3.)

The angular speed of the earth is about $2 \times 10^{-7}\ \frac{\text{rad}}{s}$ and the radius of its orbit about the sun is $1.5 \times 10^{11}\ m$. The radius of the orbit of the planet Mercury is $5.8 \times 10^{10}$

(a.) What is the angular speed of the Mercury? (10 points)

## Problem (4.)

A toy car with wheels of diameter 8 $cm$ rolls on a floor without slipping.

(a.) If the car travel a distance of 120 $cm$ in 10 $s$, what is the angular velocity of its wheels? (10 points)

## Problem (5.)

A 6 $kg$ mass is sliding on an inclined plane with friction. The incline makes an angle of $25^o$ with regard to the horizontal. After travelling 10 $m$, it losses 2 $J$ of energy. If its initial velocity was 15 $\frac{m}{s}$;

(a.) How far does it travel before coming to rest? (5 points).

(b.) How long does it take for the mass to stop? (5 points).

## Problem (6.)

A pendulum consists of a 10 $kg$ mass at the end of a 2.5 $m$ long rigid bar. At the lowest point of the arc, the mass has a centripetal acceleration of 20 $\frac{m}{s^2}$.

(a.) What was the height from which the mass began its swing? (10 points).