Physics 10 Fall 2019

Exam 1
Friday, October 18, 2019

Some direction:

No phones or other device that connects to the internet.

You may use a calculator. Please plug in numbers for numerical answers and keep three sig figs regardless of the actual correct number of sig figs in the problem.

Present clear and complete answers:

Explain your answers clearly but briefly. You want to aim for a level of solution that someone taking this class would be able to understand. A diagram and a few words may help.

Start calculations with first principles: things like definitions ($\vec{a} \equiv \frac{d\vec{v}}{dt}$) or empirical laws (like Coulomb's Law or Newton's Laws) or conservation laws.

Check time:

The point values for each problem are shown next to the question number. Time yourself accordingly. There are eight problems on the exam, for a total value of 100 points. **Good luck!**

Some constants:

$g = 9.8$ m/s^2 $\qquad$ $G = 6.67 \times 10^{-11}$N m^2/kg^2

Some helpful equations:

$$\Delta\vec{r} \equiv \vec{r}_f - \vec{r}_i$$

$$\vec{v} \equiv \frac{d\vec{r}}{dt} \qquad \vec{v}_{AVE} \equiv \frac{\Delta\vec{r}}{\Delta t}$$

$$\vec{a} \equiv \frac{d\vec{v}}{dt} \qquad \vec{a}_{AVE} \equiv \frac{\Delta\vec{v}}{\Delta t}$$

$$\vec{v} = \vec{v_0} + \vec{a}t$$

$$\vec{r} = \vec{r_0} + \vec{v_0}t + \frac{1}{2}\vec{a}t^2$$

$$\Sigma\vec{F} = m\vec{a}$$

$$\vec{F}_{12} = -\vec{F}_{21}$$

$$\vec{F}_g = m\vec{g}$$

$$F_{fr} = \mu F_N$$

$$a_c = \frac{v^2}{r}$$

$$F_G = G\frac{Mm}{r^2}$$

NAME:_____

1. (10 points) Physicists try to find mathematical models for predicting the behavior of natural phenomena. In doing so, we define physical concepts in terms of mathematical quantities such as position, time, distance, displacement, velocity, speed, acceleration, mass, and force.

   List 4 physical quantities which are vectors.

2. (10 points) A vector is given in column notation as $\vec{A} = \begin{bmatrix} 2 \\ -3 \end{bmatrix}$ Write the vector as magnitude and direction. (Don't forget to show your work.)

3. (5 points) A book slides down a smooth incline. (Ignore friction.) The incline makes an angle of 25° relative to the horizontal. Draw a free body diagram for the book.

4. (10 points) What would happen to the gravitational force between two objects if the distance between them were doubled?

5. (15 points) Two (and only these two) forces act on an object of mass 1.5kg. $\vec{F_1} = \begin{bmatrix} 10N \\ 20N \end{bmatrix}$ and $\vec{F_2} = 10$ N @ $126.9°$. What is the acceleration of the object?

6. (15 points) A physics professor throws a pen into the air with an initial velocity of 4m/s at an angle of 50° relative to the horizontal. (Imagine the prof was crouched down and threw it from ground level.)

   (a) How long does it take for the pen to get to the highest point?

   (b) How high does it go?

   (c) What is the pen's velocity right before it hits the ground?

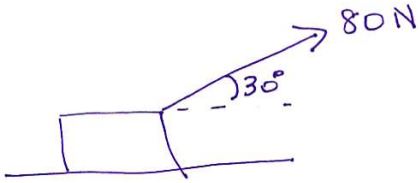
7. (20 pts) A crate is pulled across the *rough* floor of a warehouse with a force of 80 N at an angle of 30° above the horizontal. The box has a mass of 15 kg and accelerates at a rate of 2 m/s^2. (Don't ignore friction.)

   (a) Draw a free-body diagram for the crate.

   (b) What is the magnitude of the friction force acting on the crate?

   (c) What is the coefficient of kinetic friction between the crate and the floor?

   (d) If the crate starts from rest, how far does it travel after 10 seconds?



8. (15 pts) A satellite orbits the earth at a height of one earth radius above the surface of the earth. (The radius of the earth is $R_E = 6.00 \times 10^6$m, and the mass of the earth is $M_E = 6.00 \times 10^{24}$kg.)

   (a) If the orbit is a uniform circle, what is the magnitude and direction of the satellite's acceleration?

   (b) How long does it take the satellite to complete one orbit?