Name (printed neatly) _____

General Physics 121 - Exam 1 – September 28, 2018

Time started _____ (enter immediately upon starting exam!)

Place taken _____

Time ended _____ (enter immediately upon completing exam!)

- To receive full credit for a problem, your work must convincingly demonstrate that you understand the physics involved behind the problem. That means not only providing the correct answer but showing how you obtained your answer.
- Questions represent a mix of conceptual and quantitative issues. Questions are scored according the rubric on the next page
- You may not consult the textbook, your notes, or any source of information other than the equations below.
- Include raw algebraic equations and identify variables. Include units (m, s, m/s, etc.) in calculations and carry them through.
- You may choose any continuous, uninterrupted 3-hour period in which to take this exam.
- You may use a calculator provided it is not programmed with course-specific information.
- It is important that your answers be neat and clear. Legible handwriting and clear exposition are required, not optional.
- Use only one side of each page of paper.
- Box your final answers to help me locate and identify them quickly
- Use your own, lined paper. Nothing written on this exam will be graded. Do not use paper ripped from a spiral-bound notebook with jagged edges.
- Do not write your name on any of the pages other than this cover sheet.
- Start each answer on a new sheet of paper.
- When finished, place this exam atop your paper and staple them together with your responses to the questions in sequential order before handing them in.
- You must turn in the exam to Dr. Pontius unless other arrangements have been made.
- **I reserve the right to assign additional penalties for violating these instructions.**

Signing the honor code also affirms that you are taking the exam during a time period that does not conflict with any other academic obligations.

Honor code:

Reminder: Show all your work. Explain thoroughly and justify everything.

Don't Panic!

$$\Delta x = x_f - x_i \qquad \Delta t = t_f - t_i \qquad \Delta v_x = v_{xf} - v_{xi}$$

$$v_{x,av} = \frac{\Delta x}{\Delta t} \qquad v_x = \frac{dx}{dt} \qquad v_{xf} = v_{xi} + a_x \Delta t$$

$$a_{x,av} = \frac{\Delta v_x}{\Delta t} \qquad a_x = \frac{dv_x}{dt} \qquad v_{xf}^2 = v_{xi}^2 + 2a_x \Delta x$$

$$\vec{F}_{net} = m\,\vec{a} \qquad F_g = m\,g \qquad x_f = x_i + v_{xi}\Delta t + \frac{1}{2}a_x(\Delta t)^2$$

$$F_{fk} = \mu_k F_N \qquad F_{fn,max} = \mu_s F_N \qquad \vec{F}_{12} = -\vec{F}_{21}$$

$$a_r = \frac{v^2}{r} \qquad v_{av} = \frac{v_f + v_i}{2} \qquad \vec{\boldsymbol{r}} = x\hat{\mathbf{i}} + y\hat{\mathbf{j}} + z\hat{\mathbf{k}}$$

g = 9.80 N/kg	1 N = 0.225 lb	a_g = 9.80 m/s^2
1 mile = 1619 m	1ft = 0.305 m	1 inch = 2.54 cm
1 ton = 10^3 kg	1 mile = 1.609 km	1 Btu = 252 cal

Coefficients of friction	μ_s	μ□
Wood against wood	0.43	0.37
Wood against concrete	0.62	0.45
Rubber against concrete	0.95	0.80
Kitten against carpet	2.57	-

Grading rubric:

Level of demonstrated understanding	Example	Score
Complete	Correct reasoning and answer	10
	Correct reasoning; minor computational mistakes or omissions; reasonable answer	9
Partial	Some physics errors or a correct setup but no or incomplete execution; substantial omissions	7
	Major physics errors or partial justification provided even if answer is correct; major omissions	5
Little to none	Little of relevance or no justification provided even if answer is correct	3
	Very little of relevance; moderately interesting B. S.	1
	Blank or just a restatement of the question	0

1. Every night, I perform the time-honored ritual of Feeding the Cats. Thelma and Louis have some health issues, so their food must be mixed with a ground up pill mixed with 1 oz of food. Using a spoon, I scoop out a small glop, then drop it from above onto a scale carefully tared to read zero. Let's say I nail it and have exactly 1.0 oz of food on my spoon. But the scale initially reads something larger, typically 1.1 oz, before returning to 1.0 oz. Explain why the scale behaves as it does. (Note: "oz" indicates "ounce," a unit of force used to quantify weight in some cultures. Do not let the fact that Professor Pontius is not using the metric system here disrupt your world view.)

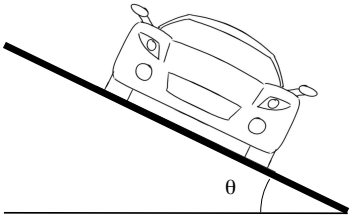
2. One day while walking across the quad, you look upward and see an airplane approaching. It's flying level and in a short time will pass directly over you. If something drops from the plane at the very instant that you see it at 45° above the horizon, find the relationship between the airplane's speed v and height H for it to hit you. That is, given H, how fast would the plane have to be moving for the object to hit you? (You may ignore air resistance and your own speed relative to that of the airplane.) Give your answer in terms of H, v, and a_g (and don't substitute a numerical value for a_g). Explain your logic.

3. Spaceman Spiff's ship starts from rest and accelerates at constant rate a_o straight toward the Blerg monster in an attempt to distract it from devouring a defenseless scientific outpost. After a brief period, he realizes that this hideous villain is too much for him, and he throws the engine into reverse, producing a constant acceleration of a_o in exactly the opposite direction. (Assume the acceleration changes instantaneously.) Construct qualitative graphs of Spiff's motion as a function of time, from his starting position at rest through equal time intervals for the two periods of different constant acceleration. Show acceleration, velocity, and position (hint: work in that order), in three separate panels stacked vertically with time coordinates aligned. Your figures need not be quantitatively precise, but they should be qualitatively correct, and you should describe their geometric features sufficiently for me to interpret what you're trying to depict. Explain your reasoning and discuss the logic underlying the features your graphs.

4. A man pushes a crate of mass 200 kg at a constant speed of 0.73 m/s up a ramp inclined at 15° above the horizontal floor.
   (a) Neglect any friction acting on the crate. Calculate the magnitude of the force applied by the man if he pushes parallel to the ramp.
   (b) Now calculate the magnitude of the force applied by the man if he pushes horizontally, i.e., parallel to the floor not to the ramp the block is still sliding up.
   (c) Repeat part (b) if there are coefficients of friction $\mu_{\square} = 0.20$ and $\mu_s = 0.25$ between the crate and the ramp.

   Show all your work and explain your reasoning.

5. A race car rounds a racetrack banked at angle θ while maintaining a circular path of constant radius *R* and a constant speed *v*.



   (a) A skilled driver will drive at a speed where the only force the track exerts on the car is the normal force, i.e., the force of friction is zero. Sketch the free-body diagram for that situation, then explain in words the directions of the forces acting on it and give their relative magnitudes, i.e., which is bigger?
   (b) A less skilled driver under those same circumstances will drive at a speed where friction is required as well. For the same radius *R* and angle θ□□□□□different speed *v*, explain how to determine the direction of friction based on your free-body diagram. Does the answer depend on whether the driver is going too fast or too slow? Explain.

6. A 2,460-kg Ford Excessive SUV driven by NYPD's Finest (a self-congratulatory laudatory epithet meaning "police") needs to move a parked 1380-kg Prius illegally parked on the street out of the way for an upcoming parade. The officer brings the SUV's push bar on its front bumper up against the rear bumper of the Prius, then revs the engine and pushes horizontally until they both accelerate forward in contact at 0.42 m/s^2. Yes, the Prius' tires produce noxious smoke as they are dragged across the roadway. Find the force exerted by the SUV's tires on the concrete roadway. Is this scenario plausible?