YOUR NAME – ____

PHYSICS 121 – Quiz #1

Useful constants: $\pi = 3.14159265...$

1) Answer the following questions in terms of a power of 10 (e.g. a centimeter=$10^{-2}\ m$)
   a) How many meters are in
      i) a kilometer?
      ii) a nanometer?
   b) How many bytes are in a Terabyte?
   c) How many seconds are in a microsecond?

For Question 2, show all work. (Explicitly show all conversions and all numbers that you will plug into your calculator, even though you will use your calculator to finish the calculation).

2) The circumference of a bowling ball is 2.250 feet. Calculate its surface area in square millimeters. Show your result to 4 significant figures using scientific notation. (One inch is 2.540 cm).

YOUR NAME – ____

PHYSICS 121 – Quiz #2

Equations:

$$E = mc^2 \qquad v^2 = v_0^2 + 2a(x - x_0) \qquad \vec{F} = \frac{d\vec{p}}{dt} \qquad x = x_0 + v_0 t + \frac{1}{2}at^2$$

$$v = \frac{dx}{dt} \qquad a = \frac{d^2x}{dt^2} \qquad v = v_0 + at \qquad \vec{F} = -\frac{Gm_1m_2}{r^2}\hat{r}$$

1) It's New Year's Eve in New Mexico. Three people (two with guns) are standing on top of a really tall cliff. At precisely the stroke of midnight, person "A" fires their gun straight up. Person "B" hangs the gun over the edge and fires it straight down. Person "C" has no gun; they throw a rock straight up at midnight. One second later, bullet A is still headed upward, bullet B has not yet hit the ground, and rock C has reached its peak altitude and is about to fall back to Earth. At this instant, compare the accelerations of "A", "B", and "C". (Put them in order, smallest to largest or indicate which, if any, are equal). Write a one or two sentence explanation of your reasoning. (Ignore air resistance).

For Question 2, show all work. Indicate which equations you are using. Draw a sketch. Indicate what you are solving for. Show the equations with proper numbers plugged in; THEN come up with a numerical answer.

2) A drunk driver parks a truck on the railroad tracks and falls asleep. The conductor of a 100-car freight train first sees the truck from a distance of 0.440 kilometers and immediately slams on the brakes and blows the horn. Measurements of the distance pieces of the truck were thrown lead police to the conclusion that the truck was hit at 25 m/s. Assuming the train had a constant deceleration of 0.33 m/s^2,

a) What was the original speed of the train?
b) Assuming he could hear the train's horn, how long did the truck driver have to wake up and bail out before the vehicle was hit?

YOUR NAME – ____________________________________

PHYSICS 121 – Quiz #3

Useful Trig. Values:

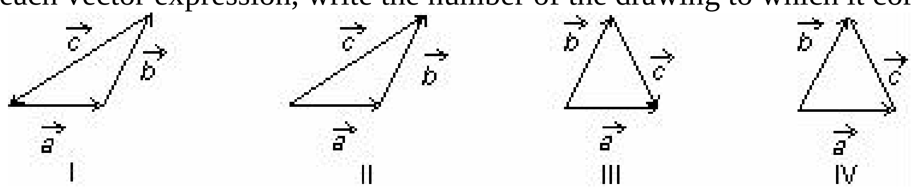
$\cos(0) = 1, \quad sin(0) = 0, \quad tan(0) = 0$

$\cos(30^\circ) = \sqrt{3}/2, \quad sin(30^\circ) = 1/2, \quad tan(30^\circ) = \sqrt{3}/3$

$\cos(45^\circ) = \sqrt{2}/2, \quad sin(45^\circ) = \sqrt{2}/2, \quad tan(45^\circ) = 1$

$\cos(90^\circ - \theta) = sin(\theta), \quad sin(90^\circ - \theta) = \cos(\theta), \quad tan(\theta) = \frac{sin(\theta)}{\cos(\theta)}$

1) For each vector expression, write the number of the drawing to which it corresponds:



a) $\vec{c} = \vec{a} - \vec{b}$ __________
b) $\vec{c} = \vec{a} + \vec{b}$ __________
c) $\vec{c} = \vec{b} - \vec{a}$ __________

2) Let $\vec{\mathbf{V}} = 3\hat{\mathbf{i}} - 4\hat{\mathbf{j}}$. The magnitude of $\vec{\mathbf{V}}$ is:___________

3) A group of skier terrorists abducts you to the top of Sandia Tram. Using your superior knowledge of projectile motion, you are to tell them the muzzle velocity to which they should set their mortar in order to destroy the lower tram station. Their mortar is set to an angle 30 degrees above horizontal, and is at an altitude 1000 meters above the lower tram station (their target). The horizontal distance between the mortar and the target is 4000 meters. Your secret plan is to have the mortar hit their temporary base instead of the lower tram station. Their base (your actual target) is at the same altitude as the lower tram station, but another 100 meters horizontally further from their mortar. What muzzle velocity do you tell them to use? Three significant figures is sufficient.

YOUR NAME – ______________________________________

PHYSICS 121 – Quiz #4

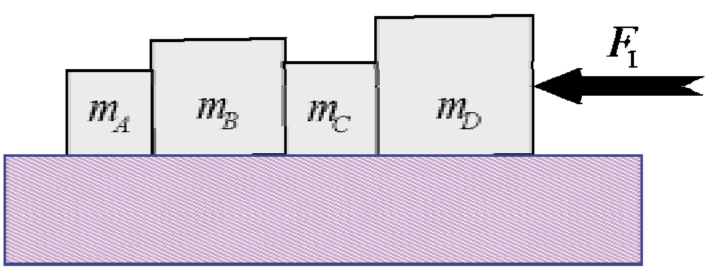
[Solve problem 2 on the back]

1) A block of wood of mass "m" slides down a rough ramp ("rough ramp" implies frictional force). The ramp itself is massless, and it is inclined at 30 degrees above horizontal.

a) Sketch the block on the ramp. (Try to get the angle about right, but it does not have to be exact).

b) Do a free-body diagram for the block. Indicate all forces with arrows (you do not need to break them up into components). Label all forces with a descriptive letter.
Define what your letters mean (name the forces).

c) Do a free-body diagram for the ramp. Indicate all forces and label them. For third-law pairs, the labels for block and ramp should correspond.



2) Blocks A, B, C and D are arranged as shown. A force $F_1 = 48\ N$ is applied to block D.
$m_A = 1\ kg,\ m_B = 5\ kg,\ m_C = 2\ kg,\ m_D = 8\ kg$

There is no friction between blocks and table.

a) What is the acceleration of the blocks?
b) What force does block C apply to block B?
c) A massless spring with spring constant $k = 900\ N/m$ is placed between block B and block C. A different force F_2 is applied to block D, and it is observed that the spring compresses by 3 cm. What is the acceleration of the blocks now?

YOUR NAME – ____

PHYSICS 121 – Quiz #5

Equations:

$E = mc^2$ $v^2 = v_0^2 + 2a(x - x_0)$ $\vec{F} = \frac{d\vec{p}}{dt}$ $x = x_0 + v_0 t + \frac{1}{2}at^2$

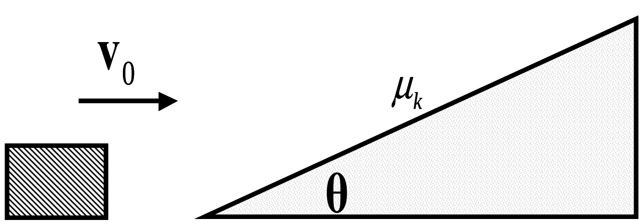
$f = \mu\, n$ $v = \frac{dx}{dt}$ $a = \frac{d^2x}{dt^2}$ $\vec{F} = -\frac{Gm_1m_2}{r^2}\hat{r}$

1) You have a mass m=50 kg. You are in an elevator descending at a constant velocity of $\vec{\mathbf{v}}_0 = -5.0\, m/s\ \hat{\mathbf{k}}$. (Assume g=9.8 m/s^2 and that $\hat{\mathbf{k}}$ points up).
The most likely value for the normal force applied to your feet by the elevator floor is:

a) 590 N   b) 490 N   c) 390 N   d) 290 N

2) A few seconds after the situation of problem 1, the elevator comes to a stop on the first floor. While the elevator is slowing down, the most likely value for the normal force applied to your feet by the elevator floor is:

a) 590 N   b) 490 N   c) 390 N   d) 290 N



3) A block slides on ice toward a ramp (inclined by $\theta = 30^\circ$). The block has an initial velocity of magnitude $\mathbf{v}_0 = 3.0\, m/s$. When the ice is sliding on ice, you may assume there is no friction. However, when the ice begins to ascend the wooden ramp, the friction coefficient is $\mu_K = 0.25$.

a) How far does the ice block go up the ramp? (Give a number, in meters)
b) Answer the question symbolically for arbitrary θ, $\mathbf{v}_0$, μ_K.

YOUR NAME – ____

PHYSICS 121 – Midterm Test

To save time, you may assume $g = 10\ \frac{m}{s^2}$.

If you do not know a conversion factor , a formula or a trig. value, state your best guess, then proceed with this value. You will lose some credit, but if you are consistent you can get substantial partial credit.

It is not necessary to show your work, but it is highly recommended in order to obtain partial credit.

1) The average density of Earth is $\rho_{EARTH} = 5.44\ \frac{g}{cm^3}$. The diameter of Earth,

$D_{EARTH} = 12{,}800\ \ km$.

Use this information to calculate the mass of planet Earth (M_{EARTH}).

===

2) A bug crawls outward from the center of a compact disc (CD) spinning 200 times per minute. The bug crawls outward without difficulty until it gets to be 1.5 centimeters from the center of the CD, at which point it starts sliding and is flung from the disc.

a) Draw a free-body diagram of the bug.

b) What was the coefficient of static friction between the bug's legs and the disc?

===

3) You're speeding at 37.8 m/s when you notice that you're only 40.0 feet behind the car in front of you, moving at the legal speed limit of 28.0 m/s. You slam on your brakes, and your car decelerates at $4.2\ \frac{m}{s^2}$. Assuming the car in front of you continues at constant speed, will you collide? If so, at what relative speed? If not, what will be the distance between the cars at the point of closest approach?

===

4) Consider particle P to which is applied force F.

$\vec{\mathbf{r}}_1 = -3\mathbf{i} + 4\hat{\mathbf{j}}\ \ m$ the initial position of particle P.

$\vec{\mathbf{r}}_2 = 2\mathbf{i} + 7\hat{\mathbf{j}}\ \ m$ the final position of particle P.

$\vec{\mathbf{F}} = -\mathbf{i} - 0.5\hat{\mathbf{j}}\ \ N$ A constant force F that will push on P.

a) How far is P from the origin when it is at $\vec{\mathbf{r}}_1$?

b) P moves from $\vec{\mathbf{r}}_1$ to $\vec{\mathbf{r}}_2$. What distance has P moved? (Answer both with a vector and a magnitude of that vector).

c) If force $\vec{\mathbf{F}}$ is applied to the particle to move it from $\vec{\mathbf{r}}_1$ to $\vec{\mathbf{r}}_2$, how much work is done?

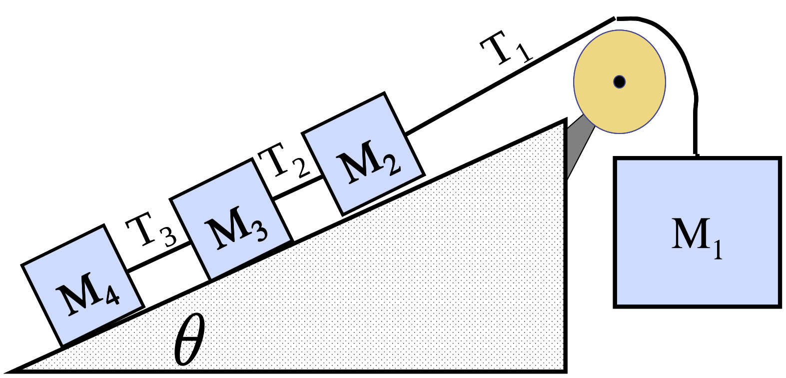
d) If the initial speed of P is 3 m/s (at $\vec{\mathbf{r}}_1$), what is its speed at $\vec{\mathbf{r}}_2$? (Assume that P has a mass of 2 kg.)

5) I kick a soccer ball at an angle $\theta_1 = 45^\circ$ above horizontal, giving it an initial velocity of magnitude $\mathbf{v_0}$ = 20 m/s .

a) What horizontal distance away does it land on a flat field?
b) What horizontal distance can I kick it up a 30° slope?
===
6) In the arrangement shown below, $\theta = 30^\circ$, $M_2 = 2\,kg$, $M_3 = 3\,kg$, $M_4 = 4\,kg$, . The coefficient of kinetic friction between the ramp and the masses is $\mu_K = 0.2$. Mass M_1 has no friction, and is large enough to pull the other 3 masses up the ramp. The pulley has no friction, and the string joining all the masses has no mass.

The string will break when the tension exceeds 100 N anywhere:

a) Between which two masses will the string break?
b) If the tension is at its maximum so that the string is barely holding together, what is the acceleration of the masses?
c) At this time, calculate the other two tensions (the ones that are smaller).
d) What is the value of mass M_1 ?



YOUR NAME – ____

PHYSICS 121 – Quiz #6

EXTRA CREDIT

These problems will be added to your midterm score.

1) Scientific notation and units.
Electrons are so light that it is easy to give them extremely large accelerations. Accelerating electrons emit energy (If they did not there would be no radio, no TV, and no light!).

There is a formula from 3rd year physics, which describes the amount of power (P) radiated by a single electron undergoing acceleration "a". Fortunately, you do not need to understand the origin of the formula to use it in two calculations. For a single electron:

$$P = \frac{q^2}{6\pi\,\varepsilon_0\,c^3}a^2$$

You need to know the following:

$q = 1.6\times10^{-19}\ Coulombs$ q is the charge of a single electron.

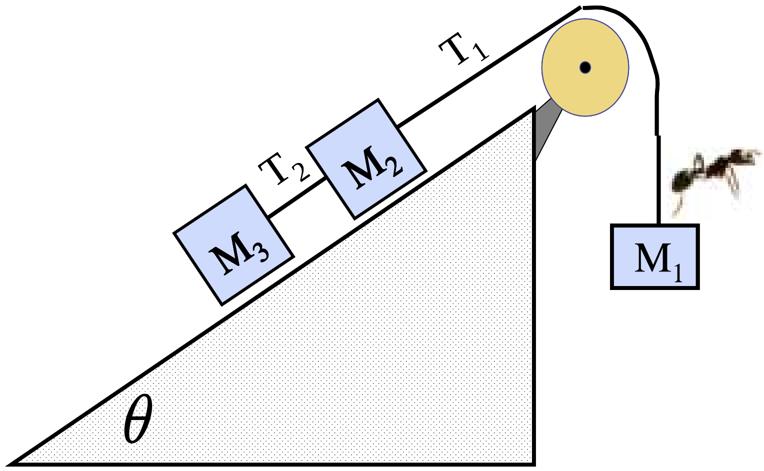
$c = 3.0\times10^{10}\ \frac{cm}{s}$ c is the speed of light

$\varepsilon_0 = 8.9\times10^{-12}\ \frac{Coulomb^2}{N-m^2}$ ε_0 is called the "permeability of vacuum"; To you it's just a conversion factor to make sure that the units come out right.

I will also tell you that Coulombs and Volts are actually SI units, so if you make sure that the units you understand are converted to SI units, the answer for P will actually come out in Watts.

So:

How many Watts does a single electron radiate if it is given acceleration $a = 1\times10^{9}\ \frac{cm}{s^2}$?



2) Newton's Laws.
In the arrangement shown, θ is not given, but you are told that the ramp is a 3-4-5 triangle (drawn roughly to scale). $M_2 = 2\,kg$, $M_3 = 3\,kg$. The coefficient of static friction between the ramp and the masses is $\mu_S = 0.5$, while the coefficient of kinetic friction is $\mu_K = 0.2$. Mass M_1 has no friction, and is large enough to just balance the other 2 masses on the ramp. A tiny ant, of negligible mass, is standing on M_1, and all the masses are at rest. The ant jumps off, and this tiny change is enough to start masses M_2 & M_3 accelerating DOWN the ramp.

Two Hints:
[1] In both parts a) and b), the friction force is pointing UP the ramp (opposing motion or possible motion)

[2] The moment masses start moving, the friction coefficient changes from its static value to its smaller kinetic value.

a) What is the mass M_1?
b) After the ant has jumped off of M_1, what is the tension T_2?

3) Energy Methods (Chapter 7)

A crane operator is demolishing a building. He pulls the wrecking ball back until its support cable is 30 degrees from vertical and then releases it. When it strikes the building, the support cable is vertical. The wrecking ball hits the building at 5.0 m/s.

a) Sketch this problem.
b) How long is the support cable?

YOUR NAME – ____

PHYSICS 121 – Quiz #7

You have been called upon to investigate an accident at the corner of California and Bullock. A small blue car (mass m_1 =1200 kg) traveling East on Bullock collided with a red pickup truck (mass $m_2 = 1500$ kg) traveling North on California. As a result of the collision, the two vehicles stuck together, brakes locked, and slid in a direction $\phi = 30^\circ$ East of North. Skid marks indicate that the vehicles slid L=11 m before coming to a stop. The coefficient of kinetic friction between tires and pavement is found to be $\mu_K = 0.8$.

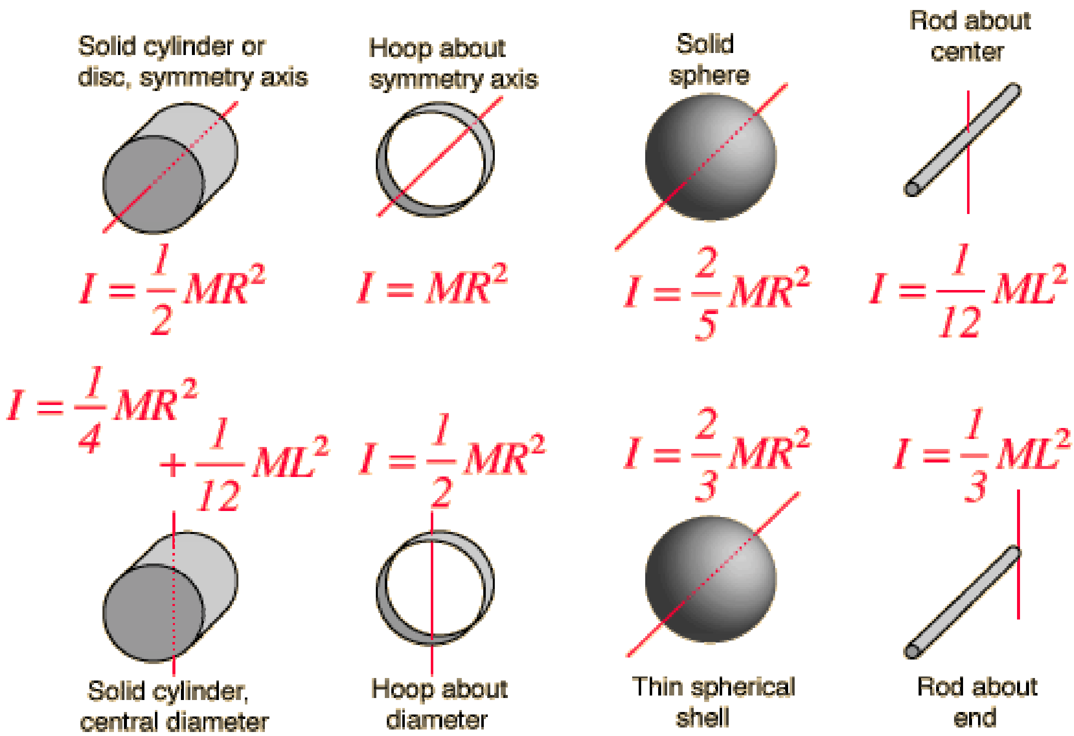
a) Sketch the accident. Indicate the momentum vectors before and after the collision.

b) Assuming that the velocity immediately after the collision is v, write a (symbolic) equation relating v, μ_K, m_1, m_2, g and L (some of these terms may cancel, or not be present at all).

c) Calculate the final speed of the joined vehicles and the initial speed of each vehicle. Who (if anyone) was speeding?
[The speed limit is 35 mph (15.6 m/s) on both roads]

YOUR NAME – ____

PHYSICS 121 – Quiz #8



1) The propeller of a single-engine airplane consists of four blades, each of mass 10.0-kg and length 123 cm. The blades may be treated as uniform thin rods.

a) How much work is required to spin the propeller up from zero rpm to 420 rpm? (1 rpm= 1 revolution per minute)

b) If the propeller begins at 420 rpm at t=0, and is driven by an engine that develops a constant torque of 2400 $N-m$, how many revolutions will the propeller make before it reaches 1800 rpm?

YOUR NAME – ____

PHYSICS 121 – Quiz #9 [Last Quiz]

Useful Constants: $G = 6.67\times10^{-11}\ \frac{m^3}{kg\cdot s^2}$

Please write on the back for problem 3 and EC!

1) The gravitational field on the surface of the Earth is stronger than it is on the surface of the moon. If a rock is transported from the Earth to the moon, what properties of the rock change. (choose one answer) **[1]**

a) mass only b) weight only c) both mass and weight d) neither mass nor weight

2) The Earth's atmosphere only extends to an altitude of roughly 100 km. Astronauts are in orbit about the Earth at an altitude of 300 km and are floating around in the space station. Why are they floating around?

Use your own words. You may make a sketch if it helps your explanation. **[2]**

3) The escape velocity from a planet of radius 6000 km is 20 km/s.

a) What is its mass? **[4]**

b) What is the period of a circular orbit 1000 km above this planet? **[3]**

Extra Credit: We know at the surface of the Earth that

i) $\Delta U = mg\Delta z$

yet Newton's law of Gravitation says that ii) $\vec{F} = -\left(\frac{GMm}{r^2}\right)\hat{\mathbf{r}}$

and thus iii) $\Delta U_{12} = GMm\left(\frac{1}{r_1} - \frac{1}{r_2}\right)$

Show that equation i) follows from equation iii).