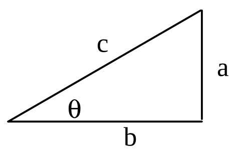
SAMPLE QUIZ 3 - PHYSICS 1301.1

This is a closed book, closed notes quiz. Calculators are permitted. The **ONLY** formulas that may be used are those given below. Define all symbols and justify all mathematical expressions used. Make sure to state all of the assumptions used to solve a problem. Credit is given only for a logical and complete solution that is clearly communicated. Partial credit will be given for a well communicated problem solving strategy based on correct physics such as the strategy illustrated in the Competent Problem Solver. MAKE SURE YOUR NAME, ID #, and TA's NAME ARE ON EACH PAGE!! Each problem is worth 25 points: **In the context of a unified solution**, a useful picture, defining the question, and giving your approach is worth 6 points; a complete physics description giving a diagram, defining the relevant quantities, identifying the target quantity, and specifying the relevant equations is worth 7 points; planning the solution by constructing the mathematics leading to an algebraic answer is worth 7 points; calculating an answer is worth 3 points; and evaluating the validity of the answer is worth 2 points. The 10 multiple choice questions are worth 25 points.

Useful Mathematical Relationships:



For a right triangle: $\sin\theta = \frac{a}{c}$, $\cos\theta = \frac{b}{c}$, $\tan\theta = \frac{a}{b}$,

$a^2 + b^2 = c^2$, $\sin^2\theta + \cos^2\theta = 1$

For a circle: $C = 2\pi R$, $A = \pi R^2$

For a sphere: $A = 4\pi R^2$, $V = \frac{4}{3}\pi R^3$

If $Ax^2 + Bx + C = 0$, then $x = \frac{-B \pm \sqrt{B^2 - 4AC}}{2A}$

$\frac{d(z^n)}{dz} = nz^{n-1}$, $\frac{d(\cos z)}{dz} = -\sin z$, $\frac{d(\sin z)}{dz} = \cos z$, $\frac{df(z)}{dt} = \frac{df(z)}{dz}\frac{dz}{dt}$, $\int\left(\frac{dw}{dz}\right)dz = w$, ,

$\frac{d}{dz}\int w\,dz = w$, $\int z^n dz = \frac{z^{n+1}}{n+1} (n \neq -1)$

$\bar{v}_x = \frac{\Delta x}{\Delta t}$	$\bar{s} = \frac{\text{dist}}{\Delta t}$	$\bar{a}_x = \frac{\Delta v_x}{\Delta t}$	$\frac{d\theta}{dt} = \frac{v}{r}$	$E_f - E_i = \Delta E_{transfer}$	$\vec{p}_f - \vec{p}_i = \Delta\vec{p}_{transfer}$
$v_x = \frac{dx}{dt}$	$s = \frac{dr}{dt}$	$a_x = \frac{dv_x}{dt}$	$\sum\vec{F} = m\vec{a}$	$KE = \frac{1}{2}mv^2$	$\vec{p} = m\vec{v}$
				$W = \int_{path} \vec{F}\bullet d\vec{\ell}$	$\vec{p}_{transfer} = \int\vec{F}dt$

Under Certain Conditions:

$x = \frac{a_x}{2}(\Delta t)^2 + v_{xo}\Delta t + x_o$	$a = \frac{v^2}{r}$	$F = \mu_k F_N$	$F \leq \mu_s F_N$	$F = kx$
	$PE = mgh$	$PE = \frac{1}{2}kx^2$		

Useful constants: 1 mile = 5280 ft, $g = 9.8\ m/s^2 = 32\ ft/s^2$

Part 1 - Problems

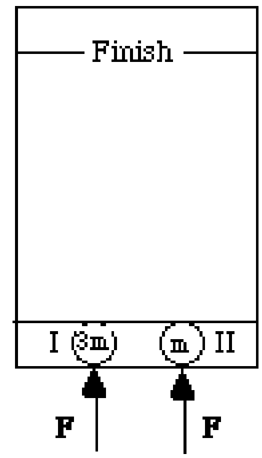
1. You have a job at a company that designs equipment for sports shows and exhibitions. The company has been given the contract to design an apparatus for an ice skating show. An ice skater will start from rest and glide down an ice-covered ramp. At the bottom of the ramp, the skater will continue gliding around an ice-covered loop inside of a vertical circle. After going around the vertical circle, the skater emerges at the bottom of the circle to glide out on the skating rink floor. To make a spectacular effect, the circular loop should have a diameter of 30 feet. Your task is to determine the minimum height from the top of the ramp to the rink floor so that the skater will not fall off the loop at the top.

2. You have a job in a research group investigating the effects of normal environmental radiation on DNA molecules in our body. To test this idea, your research group decides to determine the energy deposited in a nucleus of an atom in DNA after a neutron from the environment knocks out one of the neutrons in the nucleus. In an experiment, a neutron with an energy of 2.1 MeV, hits a nucleus of one of the atoms of the DNA molecule and knocks out only one other neutron. The two emerging neutrons are detected at 30^o and 15^o from the direction of the incoming neutron. The nucleus, still in the atom attached to the DNA molecule, remains stationary. The mass of a neutron is 1.7×10^{-27} kg.

3. You are supplying technical advice for a developing country. You have been asked to devise a very inexpensive test instrument to check the quality of springs that are manufactured for engine controls. You decide to clamp one end of spring to be tested so that it is held horizontally on a table top. It is then compressed by a specified amount and used to shoot a marble over the edge of the table onto the floor. You determine an equation that uses where the marble hits to determine the spring constant as long as you know the mass of the marble and the height of the table as well as the amount the spring was compressed.

Conceptual Questions

The figure depicts two pucks on a frictionless table. Puck I is three times more massive than puck II. Starting from rest, both pucks are simultaneously and continuously pushed across the table by **equal** forces. The next two questions refer to this situation.



1. Which puck will have the **greater energy** at the instant the first puck reaches the finish line?
   (a) puck I
   (b) puck II
   (c) They will both have the same energy.
   (d) Too little information to answer.

2. Which puck will have the **greater momentum** at the instant the first puck reaches the finish line?
   (a) puck I
   (b) puck II
   (c) They will both have the same momentum.
   (d) Too little information to answer.

3. Suppose you are pushing horizontally on a large box that moves across the floor at a **constant speed**. What do you know about the forces on the box?
   (a) If the force you apply to the box is doubled, its speed will double.
   (b) The force you apply equals the frictional force on the box.
   (c) The force you apply is greater than the frictional force on the box.
   (d) The force you apply is greater than the weight of the box.
   (e) The force you apply is greater than the force that the box applies on you.

4. An object on a vertical spring is moving up and down. When the object is at its lowest point, which of the following statements is **not true**?
   (a) Its velocity is zero.
   (b) Its acceleration is zero.
   (c) The spring's force on the object is maximum.
   (d) Its acceleration is up.
   (e) It's at its maximum displacement from its equilibrium position.

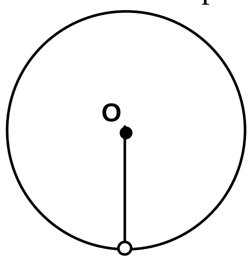
Questions 5 and 6 refer to a 16-lb bowling ball hits runs into a 2-lb bowling pin.

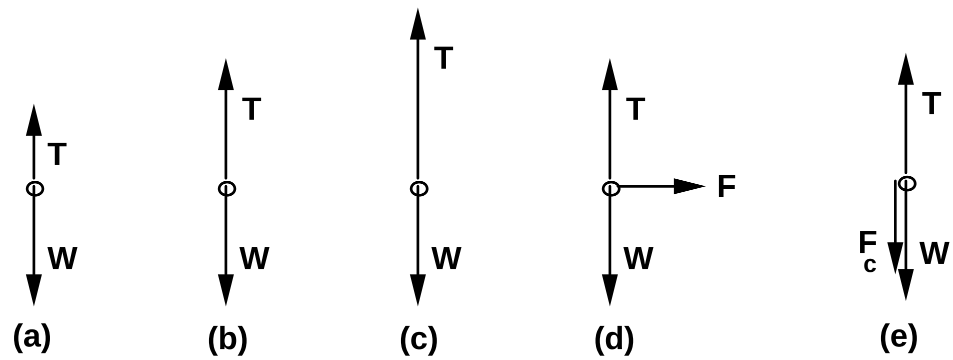
5. Compare the relative sizes (magnitudes) of the forces on the ball and pin.
   - (a) The ball exerts a greater force on the pin.
   - (b) The pin exerts a greater force on the ball.
   - (c) They exert equal size (magnitude) forces on each other.
   - (d) Only the ball exerts a force on the pin.
   - (e) Only the pin exerts a force on the ball.

6. During the impact of the bowling ball and pin, how does the **acceleration** of the ball and pin compare?
   - (a) The ball accelerates less than the pin.
   - (b) The ball and the pin have the same acceleration.
   - (c) The ball and the pin have equal accelerations, but in opposite directions.
   - (d) The ball accelerates more than the pin.
   - (e) It is impossible to tell without knowing the velocity of the ball.

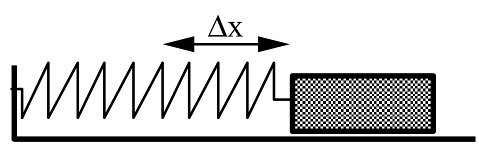
7. In order to start a car with a dead battery, you are pushing it along a road at **a steadily increasing speed**:
   - (a) the size of the force that you are exerting on the car is equal to that of the car pushing back against you.
   - (b) the size of the force that you are exerting on the car is less than that of the car pushing back against you.
   - (c) the size of the force that you are exerting on the car is greater than that of the car pushing back against you.
   - (d) whether the size of the force that you are exerting on the car is greater or less than that of the car pushing back against you depends on the weight of the car.
   - (e) whether the size of the force that you are exerting on the car is greater or less than that of the car pushing back against you depends on the frictional force.

8. Suppose you attach a ball to a string that you hold in your hand at point O and rotate at a high constant speed in a **vertical plane** in front of you. The circle shows the path of the ball. Which free-body diagram shown below represents the forces acting on the ball when it is at the bottom of the circular path and moving towards the right? Ignore air resistance.





9. A spring is attached to a wall. The other end of the spring is attached to a book. The book is pulled a distance Δx from the spring's equilibrium position and released from rest. Consider the time interval while the book is moving back to the equilibrium position. Which of the following result in an *energy input* to the system defined as the physics book?



(a) The force (pull) of the spring on the book.
(b) The frictional force of the floor on the book.
(c) The normal force of the floor on the book.
(d) The gravitational force of the earth on the book.
(e) Can't tell since energy is not conserved in this system.

10. You slam on the brakes of your car in a panic and skid a certain distance on a straight and level road. If you had been traveling twice as fast, you would have skidded

(a) eight times further.
(b) four times further.
(c) twice as far.
(d) the square root of two times further.
(e) It is impossible to tell with the information given.