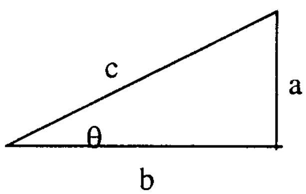
QUIZ 1 - PHYSICS 1301.2

Spring Semester February 1, 2001

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 NAMES, ID #s, and TA's NAME ARE ON EACH PAGE!! The problem is worth 25 points: In the context of a unified solution, a useful picture, defining the question, and giving your approach is worth 7 points; a complete physics diagram defining the relevant quantities, identifying the target quantity, and specifying the relevant equations is worth 8 points; planning the solution by constructing the mathematics leading to an algebraic answer and checking the units of that answer is worth 5 points; calculating a numerical value with correct units is worth 3 points; and evaluating the validity of the answer is worth 2 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: $A = 4\pi R^2$, $V = \frac{4}{3}\pi R^3$

$\frac{d(z^n)}{dz} = nz^{n-1}$, If $Ax^2 + Bx + C = 0$, then $x = \frac{-B \pm \sqrt{B^2 - 4AC}}{2A}$

Fundamental Concepts and Principles:

$\bar{v}_x = \frac{\Delta x}{\Delta t}$	$v_x = \frac{dx}{dt}$	$\bar{s} = \frac{dist}{\Delta t}$	$s = \frac{dr}{dt}$	$\bar{a}_x = \frac{\Delta v_x}{\Delta t}$	$a_x = \frac{dv_x}{dt}$

Under Certain Conditions:

$x_f = \frac{1}{2}a_x(\Delta t)^2 + v_{ox}\Delta t + x_o$

Useful constants: 1 mile = 5280 ft, $g = 9.8\ m/s^2 = 32\ ft/s^2$, 1 km = 5/8 mile

Part 1 - Group Problem

1. You have been assigned to investigate a train wreck between a fast moving passenger train and a slower moving freight train both going in the same direction. You have statements from the engineer of each train and the stationmaster as well as some measurements you make. To check the consistency the description of events leading up to the collision, you decide to calculate the distance from the station that the collision should have occurred if everyone's statement were accurate. You will then compare that result to the actual position of the wreck located 0.5 miles from the station. In this calculation you decide that you can ignore all reaction times. Here is what you know:
   - The stationmaster claims that because the freight train was behind schedule, she switched on a warning light just as the last car of the freight train passed her.
   - The freight train engineer says he was going at a constant speed of 10 miles per hour.
   - The passenger train engineer says she was going at the speed limit of 40 miles per hour when she approached the warning light. Just as she reached the warning light she saw it go on and immediately hit the brakes.
   - The train reaches the warning light 2.0 miles before it gets to the station.
   - The passenger train's brakes slow it down at a constant rate of 1.0 mile per hour for each minute they are applied.

QUIZ 1 - PHYSICS 1301.2

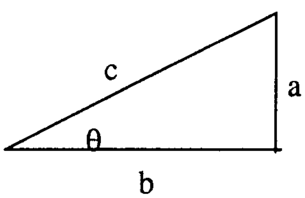
Spring Semester February 2, 2001

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 #, TA NAME, and SECTION # ARE ON EACH PAGE!! START EACH PROBLEM ON A NEW 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 7 points; a complete physics diagram defining the relevant quantities, identifying the target quantity, and specifying the relevant equations is worth 8 points; planning the solution by constructing the mathematics leading to an algebraic answer and checking the units of that answer is worth 5 points; calculating a numerical value with correct units is worth 3 points; and evaluating the validity of the answer is worth 2 points.

Part 3 is a set of 10 multiple choice questions worth 25 points.

Below is information that may be helpful in solving these problems:

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

$\frac{d(z^n)}{dz} = nz^{n-1}$, If $Ax^2 + Bx + C = 0$, then $x = \frac{-B \pm \sqrt{B^2 - 4AC}}{2A}$

Fundamental Concepts and Principles:

$\bar{v}_x = \frac{\Delta x}{\Delta t}$	$v_x = \frac{dx}{dt}$	$\bar{s} = \frac{dist}{\Delta t}$	$s = \frac{dr}{dt}$	$\bar{a}_x = \frac{\Delta v_x}{\Delta t}$	$a_x = \frac{dv_x}{dt}$

Under Certain Conditions:

$x_f = \frac{1}{2}a_x(\Delta t)^2 + v_{ox}\Delta t + x_o$

Useful constants: 1 mile = 5280 ft, $g = 9.8\ m/s^2 = 32\ ft/s^2$, 1 km = 5/8 mile

Part 2 - Problems

2. You have joined the University team racing a solar powered car. The optimal average speed for the car depends on the amount of sun hitting its solar panels. Your job is to determine strategy by programming a computer to calculate the car's average speed for a day consisting of different race conditions. To do this you need to determine the equation for the day's average speed based on the car's average speed for each part of the trip. As practice you imagine that the day's race consists of some distance under bright sun, the same distance with partly cloudy conditions, and twice that distance under cloudy conditions.

3. You have been asked to help test of the feasibility of a missile defense system. In this system, an attacking missile is detected by radar and a rocket is shot at it from the ground. To see if there is any possibility of hitting the missile, your team has devised a simplified test of the system. In this test, the attacking missile passes directly over the defense site moving horizontally with a constant speed. Its speed and height are determined by radar and, when it is directly overhead, the defensive rocket is launched. The defense rocket must have sufficient fuel to go at a constant acceleration until it hits the attacking missile. As part of the software for the computerized firing system, you must determine an equation that gives the acceleration of the defensive rocket necessary to hit the attacking missile as a function of the radar input and the angle that the rocket is fired.

Part 3 - Conceptual Questions

1. You are standing in a hot air balloon which, according to your friend on the ground, is travelling upward at 3.0 m/s. You decide to drop a rock over the side of the balloon. The instant after you release the object, your friend determines that the rock is moving with

   (a) a velocity of 0 m/s and an acceleration of 9.8 m/s^2 downward.
   (b) a velocity of 3.0 m/s upward and an acceleration of 9.8 m/s^2 downward.
   (c) a velocity of 0 m/s and an acceleration of 6.8m/s^2 downward.
   (d) a velocity of 3.0 m/s upward and an acceleration of 3.0 m/s^2 upward.
   (e) a velocity of 3.0 m/s upward and an acceleration of 0 m/s^2.

The Earth travels around the Sun in a circular orbit at a constant speed. The distance from the Earth to the Sun is about 9x10^7 miles.

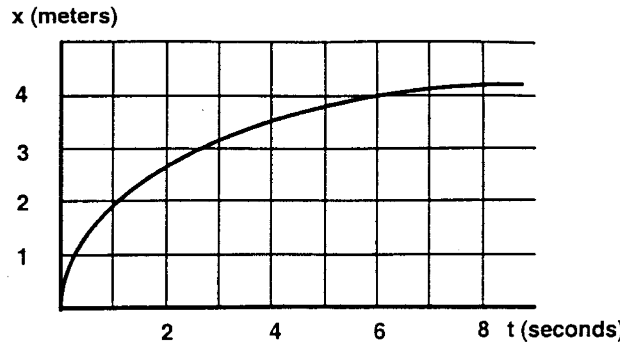
2. In one year, the Earth's average speed is
   (a) 9 x 10^7 miles/yr (b) 18 x 10^7 miles/yr (c) 9• x 10^7 miles/yr (d) 18• x 10^7 miles/yr (e) 0

3. In one year, the magnitude of the Earth's average velocity is
   (a) 9 x 10^7 miles/yr (b) 18 x 10^7 miles/yr (c) 9• x 10^7 miles/yr (d) 18• x 10^7 miles/yr (e) 0

4. The magnitude of the Earth's instantaneous velocity right now is
   (a) 9 x 10^7 miles/yr (b) 18 x 10^7 miles/yr (c) 9• x 10^7 miles/yr (d) 18• x 10^7 miles/yr (e) 0

5. The graph on the right shows how the position of an object depends on time. Which choice is closest to the magnitude of the *instantaneous velocity* of the object at 3 seconds?

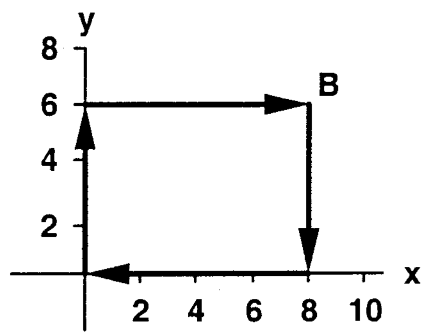
   (a) 0.10 m/s (b) 0.40 m/s (c) 0.80 m/s
   (d) 1.10 m/s (e) 3.20 m/s



Questions 6 & 7 refer to the diagram at right.

6. You start out in your car and travel 6 blocks north then 8 blocks east (to Point (B). You remember that you left your physics book at home, so you travel 6 blocks south, and 8 blocks west back to your home. Your *total displacement* for the round trip is

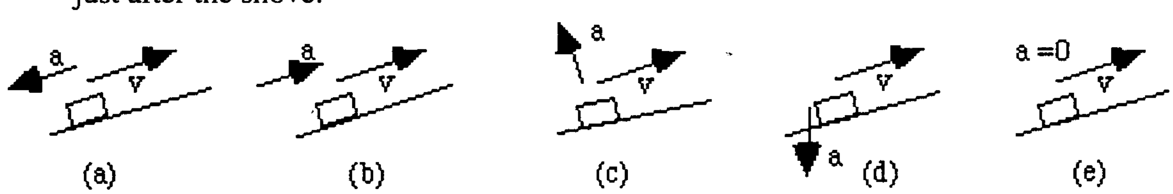
   (a) 0 blocks. (b) 6 blocks. (c) 8 blocks.
   (d) 14 blocks. (e) 28 blocks.



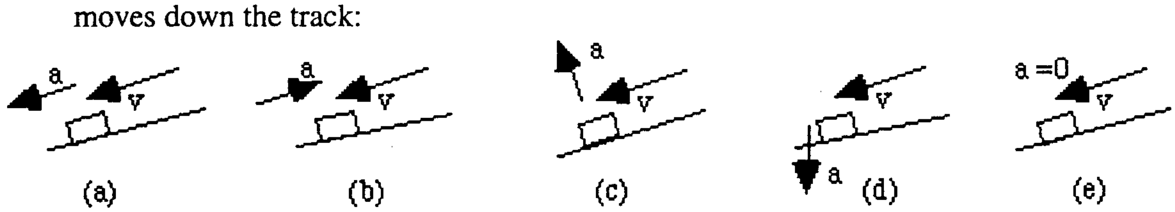
7. What was your *displacement* from home at the point you remembered your physics book, Point (B)?

   (a) 6 blocks (b) 8 blocks (c) 10 blocks (d) 12 blocks (e) 14 blocks

8. A cart is given a shove and then goes up a ramp. Which of the following best describes the situation just after the shove:



9. The cart then goes down the ramp. Which of the following best describes the situation as the cart moves down the track:



10. The cart is at its highest point on the ramp. Which of the following best describes the situation at the instant when the cart is at the highest point: