

PHYSICS 5A FALL 2000

MIDTERM I

PUT YOUR NAME ON THE EXAM RIGHT AWAY!

PLEASE SHOW ALL OF YOUR WORK. You may use the back of the page if necessary. Please clearly mark all problems for which you have information on the back of the page that you would like to be considered during the grading of the exam.

GENERAL NOTE ABOUT MY EXAMS: To whatever extent possible, you will not be penalized if an incorrect answer on an earlier part of a problem leads to an incorrect answer on a latter part of the same problem, if the approach taken to answering the latter part is otherwise completely correct. So, if you're stuck on the first part of some problem, it can often help to make your best guess at the answer, and move on to the next part whether or not you're confident in your answer to the first part of the problem.

EQUATIONS AND FORMULAE

$$v = \frac{\Delta x}{\Delta t}$$

$$a = \frac{\Delta v}{\Delta t}$$

$$x = \frac{1}{2}at^2 + v_0t + x_0$$

$$v^2 = v_0^2 + 2a(x - x_0)$$

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

$$\vec{F}_{tot} = m\vec{a}$$

$$\text{Circle: } A = \pi r^2; C = 2\pi r$$

$$\text{Cylinder: } A = 2\pi r^2 + 2\pi rh; V = \pi r^2 h$$

$$\vec{a} \cdot \vec{b} = ab \cos \theta_{ab}$$

$$\sin 60^\circ = \cos 30^\circ = \sqrt{3}/2$$

$$\sin 30^\circ = \cos 60^\circ = 1/2$$

$$\vec{v} = \frac{\Delta x}{\Delta t}\hat{x} + \frac{\Delta y}{\Delta t}\hat{y} + \frac{\Delta z}{\Delta t}\hat{z}$$

$$\vec{a} = \frac{\Delta v_x}{\Delta t}\hat{x} + \frac{\Delta v_y}{\Delta t}\hat{y} + \frac{\Delta v_z}{\Delta t}\hat{z}$$

$$v = v_0 + at$$

$$x - x_0 = \frac{1}{2}(v_0 + v)t$$

$$\vec{v}_{P/A} = \vec{v}_{P/B} + \vec{v}_{B/A}$$

$$\vec{F}_{1 \rightarrow 2} = -\vec{F}_{2 \rightarrow 1}$$

$$\text{Sphere: } A = 4\pi r^2; V = 4/3\pi r^3$$

$$\vec{a} \cdot \vec{b} = a_x b_x + a_y b_y + a_z b_z$$

$$|\vec{a} \times \vec{b}| = ab \sin \theta_{ab}$$

$$\sin 45^\circ = \cos 45^\circ = 1/\sqrt{2}$$

$$t = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

PROBLEM 1 [25 POINTS]

Two stopped cars face each other. The cars are separated by a distance of 48 meters. At precisely the same time, the two cars begin to accelerate towards each other. One car, on the left, accelerates at a rate of 2 m/s^2 to the right. The other car, on the right, accelerates at a rate of 4 m/s^2 to the left.

- a) How far from the original position of the left-hand car do the two cars collide?
- b) Instead of starting from rest, the left-hand car begins with an initial velocity v_0 . What must the value of v_0 be in order that the two cars collide at a position half-way between (24 meters from) their original positions?

PROBLEM 2 [25 POINTS]

A ball is attached to a string of length 2 m, with which it is being swung in uniform circular motion in a horizontal plane 20 m above the ground. The *instantaneous* acceleration of the ball, as it executes this circular motion, is 18 m/s^2 .

a) What is the magnitude of the *average* acceleration of the ball as it executes $1/4$ of a turn around the circle?

b) If the string breaks, through what horizontal distance does the ball travel as it falls to the ground through the height of 20 m? You may again assume that $g = 10 \text{ m/s}^2$.

PROBLEM 3 [25 POINTS]

A massless pulley is attached to a wall. A rope attached to the wall above the pulley is draped over the pulley, and a weight is suspended from the rope. The angle that the rope makes with the wall is 60° (see figure). If the pulley support can withstand a net force of no more than 1,000 N before breaking, what is the biggest mass (in kg) that can be suspended in this way? You may assume that the acceleration due to gravity is 10 m/s^2 .

PROBLEM 4 [25 POINTS]

An annoying kid keeps riding his bike right by you. You decide to take out your frustration by soaking him with a water balloon. Just as the kid rides by you for what will be the last time, you lob the balloon in the direction that he's heading, but with an upward angle relative to the horizontal of 60° . In what follows, ignore your height, as well as that of the kid on his bike. You may assume that the acceleration due to gravity is 10 m/s^2 if it makes it easier to do the problem.

- a) If the kid rides by you with a speed of 3 m/s , with precisely what speed must you lob the balloon so that your goal is accomplished?
- b) With what speed, relative to the cyclist, does the balloon strike him?