PHYSICS 5A FALL 2001

MIDTERM II

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.

EQUATIONS AND FORMULAE

$v = \frac{\Delta x}{\Delta t}$	$\vec{v} = \frac{\Delta x}{\Delta t}\hat{x} + \frac{\Delta y}{\Delta t}\hat{y} + \frac{\Delta z}{\Delta t}\hat{z}$
$a = \frac{\Delta v}{\Delta t}$	$\vec{a} = \frac{\Delta v_x}{\Delta t}\hat{x} + \frac{\Delta v_y}{\Delta t}\hat{y} + \frac{\Delta v_z}{\Delta t}\hat{z}$
$x = \frac{1}{2}at^2 + v_0t + x_0$	$v = v_0 + at$
$v^2 = v_0^2 + 2a(x - x_0)$	$x - x_0 = \frac{1}{2}(v_0 + v)t$
$a = \frac{v^2}{r}$	$\vec{v}_{P/A} = \vec{v}_{P/B} + \vec{v}_{B/A}$
$\vec{F}_{tot} = m\vec{a}$	$\vec{F}_{1\to 2} = -\vec{F}_{2\to 1}$
$w = mg$	$F = \frac{mv^2}{r}$
$f_{\rm k} = \mu_{\rm k}\eta$	$f_{\rm s} \leq \mu_{\rm s}\eta$
$W = \vec{F}\cdot\vec{s}$	$W_{tot} = \Delta KE$
$KE = \frac{1}{2}mv^2$	$P_{av} = \Delta W/\Delta t$
$P = \vec{F}\cdot\vec{v}$	$W_{grav} = mgy_1 - mgy_2 = mg\Delta h = -\Delta U_{grav}$
F = kx	$W_{elas} = \frac{1}{2}kx_1^2 - \frac{1}{2}kx_2^2 = -\Delta U_{elas}$
$KE_1 + U_1 = KE_2 + U_2$	$F(x) = -\Delta U/\Delta x$
$\vec{p} = m\vec{v}$	$\vec{J} = \Delta\vec{p} = \Sigma\vec{F}\Delta t$
$\vec{p}_{tot} = \sum_{i=1}^{n} m_i\vec{v}_i$	$\vec{r}_{cm} = (\Sigma m_i\vec{r}_i)/(\Sigma m_i)$
$\Sigma\vec{F}_{ext} = M\vec{a}_{cm}$	$\omega = \Delta\phi/\Delta t \quad \omega = v/r$
$\alpha = \Delta\omega/\Delta\phi$	$\theta = \frac{1}{2}\alpha t^2 + \omega_0 t + \theta_0$
$a_{tan} = r\alpha$	$a_{rad} = v^2/r = \omega^2 r$
$I = \Sigma m_i r_i^2$	$K = \frac{1}{2}I\omega^2$
$I_p = I_{cm} + Md^2$	$\tau = I\alpha$
Circle: $A = \pi r^2$; $C = 2\pi r$	Sphere: $A = 4\pi r^2$; $V = 4/3\pi r^3$
Cylinder: $A = 2\pi r^2 + 2\pi rh$; $V = \pi r^2 h$	$\vec{a}\cdot\vec{b} = a_x b_x + a_y b_y + a_z b_z$
$\vec{a}\cdot\vec{b} = ab\cos\theta_{ab}$	$\lvert\vec{a}\times\vec{b}\rvert = ab\sin\theta_{ab}$
$\sin 60^o = \cos 30^o = \sqrt{3}/2$	$\sin 45^o = \cos 45^o = 1/\sqrt{2}$
$\sin 30^o = \cos 60^o = 1/2$	$t = \frac{-b\pm\sqrt{b^2-4ac}}{2a}$

PROBLEM 1 [25 POINTS]

In what follows, you may assume that the acceleration due to gravity is 10 m/sec^2.

A small but dense ball weighing 5 N is attached to the ceiling by a massless 2 meter rope. The ball is pulled to one side and released; it then swings back and forth as a pendulum. (Recall that the bob of a pendulum swings back and forth along an arc of a circle.) At the instant that the rope swings through the vertical, the speed of the ball is 8 m/s. You may assume that the radius of the ball is very small compared to the length of the rope.

a) What is the net force on the ball, in magnitude and direction, at this instant?

b) What is the tension in the rope at this instant?

PROBLEM 2 [25 POINTS]

A block of mass 10 kg travels down a curved ramp of height 5 m (see Figure). It is released so that it has an initial velocity of 10 m/s at the top of the ramp. There is no friction between the block and the ramp.

The block then comes into contact and begins to compress an initially relaxed spring with spring constant $k = 20$ N/m. In what follows, you may assume that the effects of friction are small enough to ignore, and that the block smoothly compresses the spring, with no bouncing or collisional energy loss, once the block and spring come into contact. You may also assume that the acceleration due to gravity is exactly 10 m/sec^2.

a) By how many meters is the spring compressed (relative to its relaxed length) at its maximum point of compression?

b) What would your answer to part a) be if the spring were already compressed by 1 meter before the block came into contact with it?

PROBLEM 3 [25 POINTS]

A 6 kg fish, swimming east with a velocity of 2 m/s, swallows a 0.5 kg minnow which was swimming west with a velocity of 4 m/s. In what follows, you may neglect the forces exerted on either fish by the water, as well as the force of gravity.

a) What is the velocity (speed and direction) of the big fish after it swallows the minnow?

b) Is this collision elastic? Why or why not? Be *quantitative* in your answer.

c) How would your answer to part a) change if the minnow were swimming north rather than west just before it was swallowed?

PROBLEM 4 [25 POINTS]

In what follows, you may assume that the acceleration due to gravity is 10 m/sec^2.

An 8 kg block is connected by a string to a 4 kg block, both of which rest on an 30° incline (see Figure). The 8 kg block has a coefficient of friction of $\mu_k = 0.3$, and the 4 kg block of $\mu_k = 0.2$.

a) If the 4 kg block and string weren't there, what would be the acceleration of the 8 kg block?

b) With the 4 kg block and string there, as shown in the Figure, what is the acceleration of the 8 kg block?