

PHYSICS 101: Fundamentals of Physics – Exam 1

Exam 1

Name

TA/ Section #

Recitation Time

April 23, 2008, 8:00am

You have 1 hour to complete the exam. Please answer all questions clearly and completely, and that you clearly indicate your final answer to each problem (put a box around the final answer, for example). Make sure that you show all of your work. If your exam sheets do not have enough room for you to write on, please ask for more paper.

You may use a calculator, and, of course, reference the formula sheet, attached. Beyond that, the exam is entirely closed book.

Formula Sheet

(You may tear this page out)

Physical Constants

$$g = 9.8\text{m/s}^2 \simeq 10\text{m/s}^2$$
$$c = 3 \times 10^8\text{m/s}$$

Some useful math relations

$$\sin \theta \simeq \theta \quad \text{small angle}$$
$$\cos \theta \simeq 1 - \theta^2/2 \quad \text{small angle}$$
$$\frac{dC}{dt} = 0$$
$$\frac{d(t^n)}{dt} = nt^{n-1}$$
$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a} \quad \text{Quadratic Formula}$$

Projectile Relations

$$\Delta \vec{r} = \vec{r}_f - \vec{r}_i$$
$$\vec{r} = x\hat{i} + y\hat{j}$$
$$\vec{v} = \frac{d\vec{r}}{dt}$$
$$\vec{a} = \frac{d\vec{v}}{dt}$$
$$\vec{r}(t) = \vec{r}_i + \vec{v}_i t + \frac{1}{2}\vec{a}t^2$$
$$\vec{v}(t) = \vec{v}_i + \vec{a}t$$
$$v_f^2 - v_i^2 = 2a_x \Delta x$$

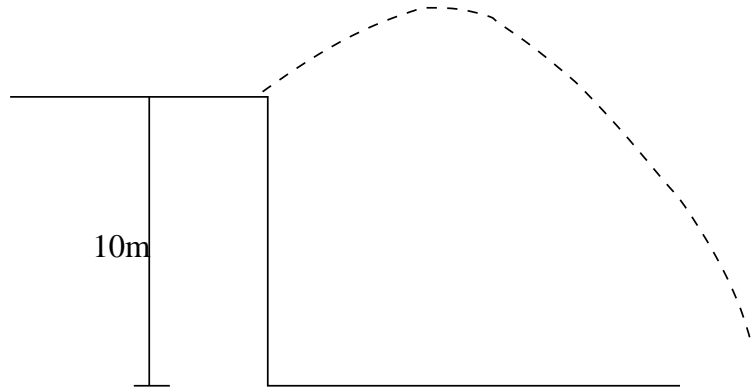
Circular Motion

$$a_c = \frac{v^2}{r}$$
$$a_t = \frac{dv}{dt} \quad \text{tangential acceleration}$$

Newton's Laws

$$\vec{F} = m\vec{a}$$
$$\sum \vec{F} = 0 \quad \text{equilibrium}$$

1. [35 *points*] You are standing at the top of a 10m cliff (as shown), throwing stones over the edge.



You throw a 0.2 kg stone at an angle of 30 degrees above the horizontal with a speed of 10m/s .

- (a) What is the x-component of the stone's velocity immediately after it leaves your hand?
- (b) What is the y-component of the stone's velocity immediately after it leaves your hand?
- (c) How long after you throw it does it reach its maximum height?
- (d) How long after you throw the stone does it take to hit the ground?
- (e) How far from the edge of the cliff does the rock hit?

2. [35 *points*] A particle is moving in 2-dimensions under the equation:

$$\vec{r}(t) = (8 + 4t)\hat{i} + (10t - 5t^2)\hat{j}$$

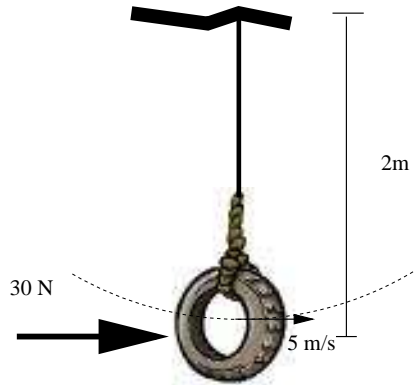
where for this once, you don't need to worry about units.

- (a) What is the *velocity* of the particle as a function of time? (Be sure to express this as a vector)
- (b) What is the *acceleration* of the particle as a function of time? (Again, be sure to express this as a vector).
- (c) At what time will the particle reach the maximum height?
- (d) How fast (at what speed) is the particle going at that time? (**Note:** if you couldn't get a numerical answer to the time in the previous part, use $t = 2\text{sec.}$)
- (e) How far from the origin is the particle at that point? (I am looking for **distance** from the origin, not displacement.) (**Note:** if you couldn't get a numerical answer to the time in part c, use $t = 2\text{sec.}$)

3. [30 points] A 5 kg Tire swing hangs by a 2m rope from a branch. At a particular moment, it is at the bottom of its arc, and it is traveling to the right at 5 m/s (as shown). Meanwhile, at that moment, a person applies a force of:

$$\vec{F} = 30N\hat{i}$$

on the tire.



- At this instant, what is the *centripetal* acceleration on the tire? In what direction is it pointing?
- What is the tangential acceleration on the tire?
- How much force does the tire exert on the person?
- How much force does gravity exert on the tire?
- Please draw a free-body diagram labeling all of the forces on the tire.
- E.C.** (4 pts) What is the tension in the rope?