Classical Mechanics

Phys105A, Winter 2007

Wim van Dam
Room 5109, Harold Frank Hall
vandam@cs.ucsb.edu
http://www.cs.ucsb.edu/~vandam/

Formalities

- Latest news and course slides always found on the Phys105A site at http://www.cs.ucsb.edu/~vandam/…

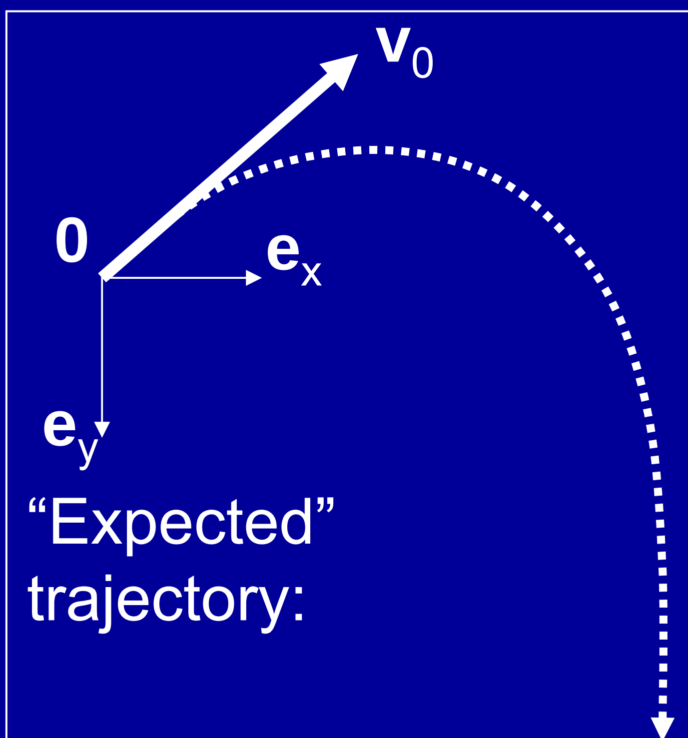
- Homework 1 has been posted.
  It is due Monday January 22, 11:30 am.
- You have to hand in two separate sets of answers so that the two TAs can grade the different questions.

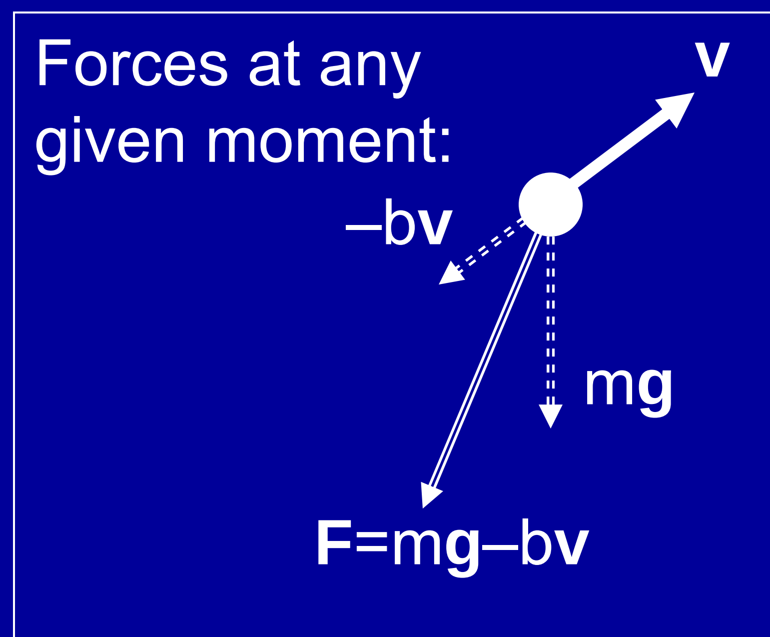
- Slides of last Tuesday are now online for real.

- Questions?

Linear Air Resistance

- Consider a flying projectile of mass m for which the quadratic drag force is negligible: **f** = –b **v**.
- Summing the forces gives **F** = m**g**–b**v** = m d**r**^{2}/dt^2.
- With **r**(0) = **0** and **v**(0) = $\mathbf{v}_0$ we expect something like:





Differential Equations

- You may have to overcome your fear of solving differential equations with pen and paper.

Tips:

1. Use your pen
2. Use lots of empty paper
3. When in doubt, try "separation of variables"
4. Know your complex valued functions

$F = mg - bv$

- Take $x_0 = y_0 = 0$ and initial speeds v_{x0}, v_{y0}.
- After some calculations [pp. 48–56] we get that

  $x = v_{x0}\,(m/b)\,(1 - e^{-tb/m})$

  $y = v_{ter}\,t + (v_{y0} - v_{ter})\,(m/b)\,(1 - e^{-tb/m})$

  where v_{ter} is the *terminal y-speed* mg/b

Note that as $t \to \infty$ we have

$x_t \to x_\infty = v_{x0}\,m/b$ and $v_{yt} \to v_{y\infty} = mg/b$.

Quadratic Air Resistance

- Consider a flying projectile of mass m with quadratic drag force: $\mathbf{f} = -c|\mathbf{v}|\,\mathbf{v}$.
- Summing the forces gives $\mathbf{F} = m\mathbf{g} - c|\mathbf{v}|\mathbf{v} = m\, d\mathbf{r}^2/dt^2$.
- Unlike the linear case, the x and y motion can now not be separated: the general case ‘can not be solved’.
- For x-motion with $x_0=0$ and v_0 we get:
  $v = v_0/(1+t\,c\,v_0/m)$ and $x = (m/c)\ln(1+t\,c\,v_0/m)$
  Note that as $t\to\infty$ we now have $x_\infty = \infty$.
- For y-motion with $y_0=0$ and $v_0=0$ we get
  $v = v_\infty \tanh(gt/v_\infty)$ and $y = v_\infty{}^2/g\,\ln[\cosh(gt/v_\infty)]$
  with terminal speed $v_\infty = \sqrt{(mg/c)}$