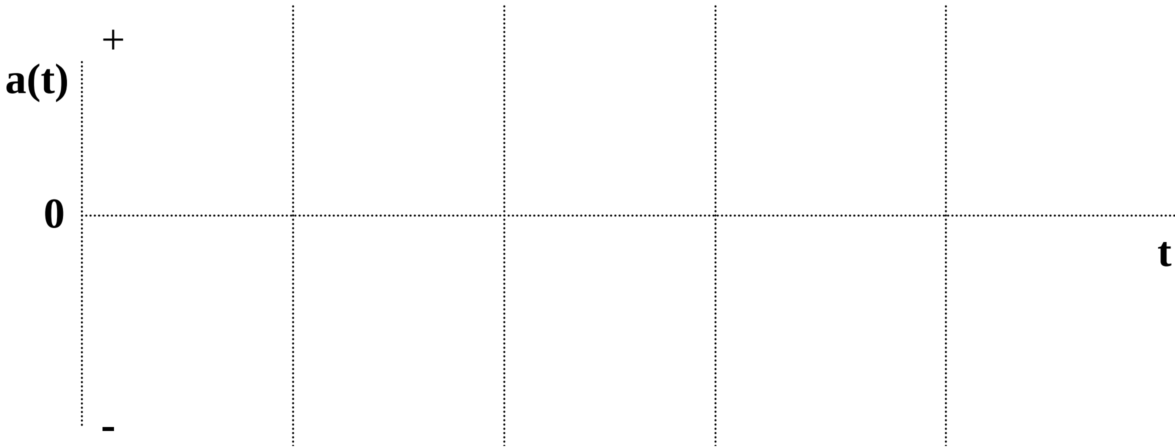
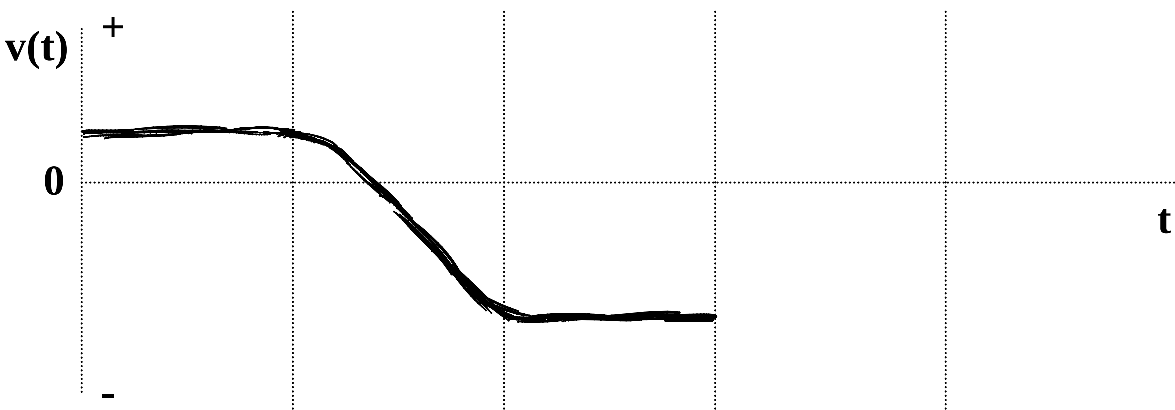
Exam 1 (October 5, 2006)

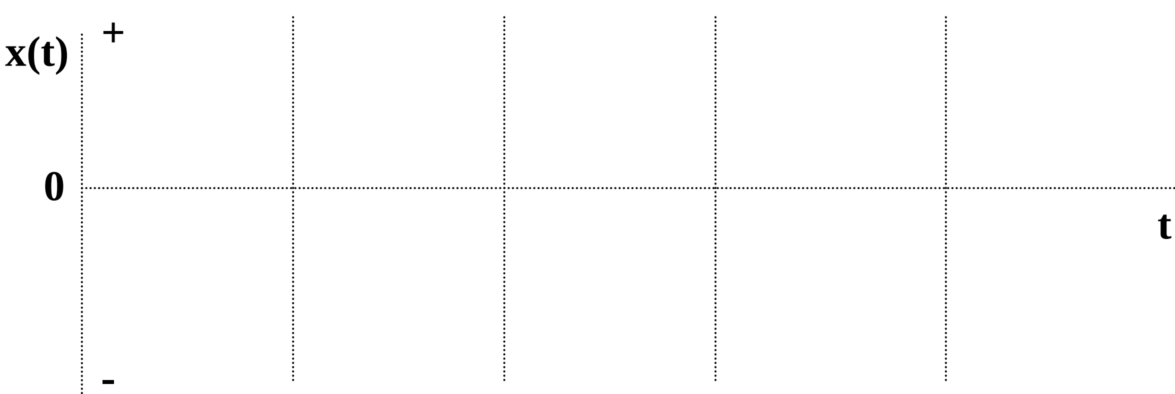
Please read the problems carefully and answer them in the space provided. Write on the back of the page, if necessary. Show all your work. Partial credit will be given unless specified otherwise.

Problem 1 (13 pts):

The 1-dimensional motion of a particle is described by the velocity-time graph given below. Sketch the appropriate qualitative acceleration-time and position-time graphs for this particle. Assume the particle starts at x=0.







1)	/13
2)	/12
3)	/12
4)	/14
5)	/14
6)	/15
7)	/20
tot	/100

Problem 2 (12 pts, show your work):

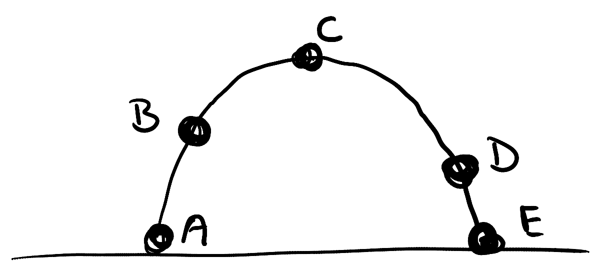
What angle does the vector $\vec{A} = 5\hat{i} - 12\hat{j}$ make with the positive x axis?

Problem 3 (12 pts, no partial credit, no need to justify):

The figure below represents the trajectory of a ball tossed in the air from point A to point E near the surface of the earth. Assume no air resistance.

What is the direction of the acceleration at point B?

a) to the right
b) to the left
c) straight up
d) straight down
e) the acceleration of the ball is zero.



At point C the velocity of the ball is

a) a maximum and directed to the right
b) directed to the left
c) a maximum
d) a minimum and directed to the right
e) a minimum and directed downward
f) zero

Problem 4 (14 pts, justify your answer):

Zorro the cat sits in a tree 3 m above the ground waiting to ambush tasty little amimals that might wonder near. Zorro spots Alvin the chipmunk running beneath him and pounces. Alvin moves in a straight line on the ground underneath Zorro at a speed of 1 m/s. Assume Zorro jumps straight out (in the horizontal direction) at the exact moment Zorro passes directly beneath him. What should Zorro's initial velocity be such that he lands squarely on Alvin? (Ignore air friction and assume both the cat and the chipmunk are small relative to the other sizes in the problem.)

Problem 5 (14 pts, show your work):

Estimate the force of attraction between the electron and the proton in the hydrogen atom. (*Hints and useful things to know: assume the electron in the hydrogen atom moves in a circle about the stationary proton with a tangential velocity half that of the speed of light. The speed of light is $3x10^{8}$ m/s. Assume the radius of the electron's orbit is $0.5x10^{-10}$ m. The mass of the electron is $9x10^{-31}$ kg and the mass of the proton is $1.7x10^{-27}$ kg.)*

Compare your estimate with the gravitational attraction between the electron and the proton.

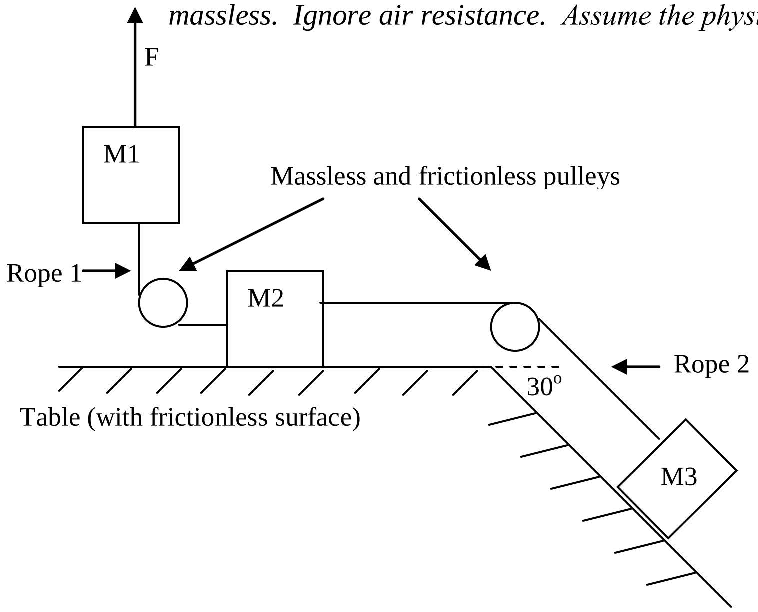
What conclusions can you draw from your answers to parts (a) and (b)?

Problem 6 (15 pts, show your work):

Ethyl Tutu is spending her fall practicing for a role in the City Ballet's production of The Nutcracker. At one point in the production, Ethyl is attached to a thin vertical wire which exerts a constant upward force on her of 300 Newtons. Unaided (i.e., no wire attached), Ethyl is able to jump vertically upward 0.5 m. How high can she jump with the wire attached?

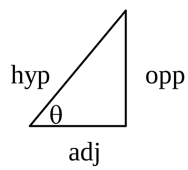
<u>Problem 7 (20 pts, show your work):</u>

Some wacked physics professor does a demo for his class that involves three masses in the configuration sketched below. The professor pulls upward on mass M1 with a force F causing M1 to move upward with an acceleration of 0.5 m/s^2. Let the masses of M1, M2 and M3 be 2 kg, 3 kg and 4 kg, respectively. The frictionless inclined plane on which M3 slides is at an angle of 30 degrees with the horizontal. Determine the magnitude of the force F exerted by the professor on M1 and the tension in each rope. *Assume M2 slides on the table without friction and M3 slides on the inclined plane without friction and that the ropes are massless. Ignore air resistance. Assume the physics class is taking place on the Earth's surface.*



$$\sin\theta = \frac{\text{opp}}{\text{hyp}}$$

$$\cos\theta = \frac{\text{adj}}{\text{hyp}}$$



$$\tan\theta = \frac{\text{opp}}{\text{adj}}$$

$$v = v_o + at$$

$$x = x_o + v_o t + \frac{1}{2}at^2$$

$$x = x_o + \left(\frac{v_o + v}{2}\right)t$$

$$v^2 = v_o^2 + 2a(x - x_o)$$

$$x - x_o = \int_{t_o}^{t} v\,dt$$

$$v - v_o = \int_{t_o}^{t} a\,dt$$

$$\sum \vec{F} = m\vec{a}$$

$$F_{centripetal} = \frac{mv^2}{r}$$

$$\vec{F} = \frac{Gm_1m_2\hat{r}}{r^2}$$

$$G = 6.67x10-11\ \text{Nm}^2/\text{kg}^2$$

$$\frac{d(x^n)}{dx} = nx^{n-1}$$

$$\int x^n dx = \frac{x^{n+1}}{n+1}$$

$$\text{circumference of circle} = 2\pi r$$

$$\text{area of circle} = \pi r^2$$

$$\text{quadratic equation} = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$