Homework Assignment #2
due in class Friday, September 15

[6] Problem 1.35 *
[7] Problem 1.38 *
[8] Problem 1.39 **
[9] Problem 1.44 *
[10] Problem 1.51 *** [computer]

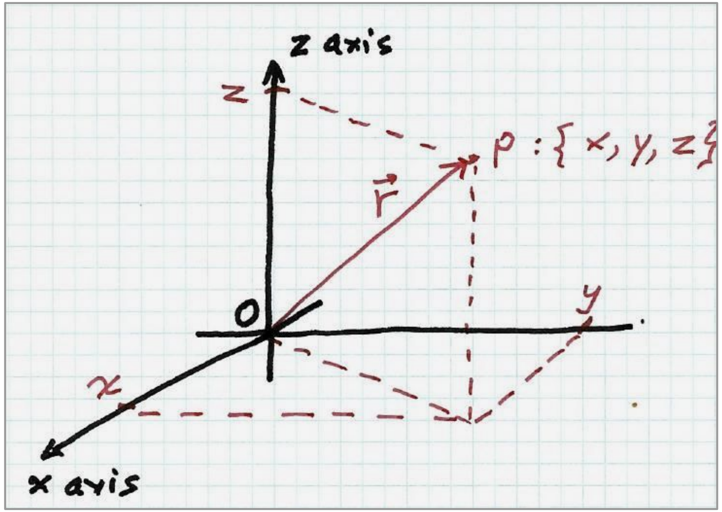
Use the cover sheet.

Computer problems.

- Your best bet is to use *Mathematica*.
- It is available in many MSU microcomputer labs; e.g., 106 Farrell Hall or 1210 Anthony Hall.
- Or, get a free student copy for your laptop.
- If you are not familiar with *Mathematica*, then do the Mathematica tutorial.

THINGS TO STUDY

SECTION 1.6
CARTESIAN COORDINATES



$$\vec{r}(t) = x(t)\,\hat{e}_x + y(t)\,\hat{e}_y + z(t)\,\hat{e}_z$$

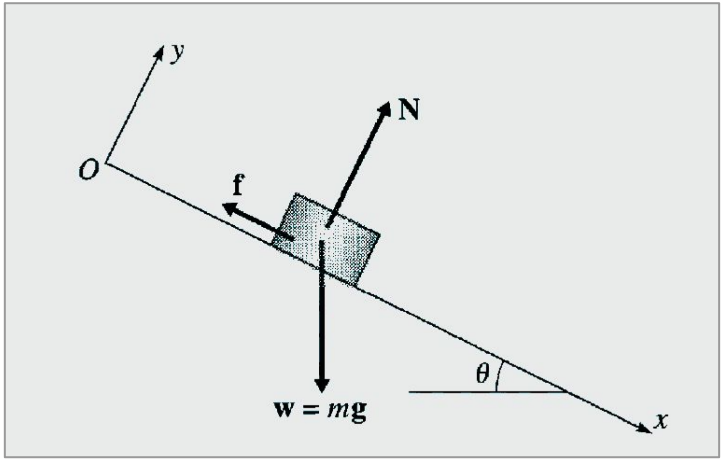
$$\vec{F}(\vec{r}) = F_x\,\hat{e}_x + F_y\,\hat{e}_y + F_z\,\hat{e}_z$$

$$\vec{a} = \ddot{\vec{r}} = \frac{\vec{F}(\vec{r})}{m}$$

$$a_x = \ddot{x} = \frac{F_x}{m} \quad \text{etc}$$

Example 1.1

A block sliding down an inclined plane



Determine the motion.

- Use the Cartesian coordinates x,y, shown in the figure.
- The result is

$$m\, dv_x/dt = mg\,(\sin\theta - \mu \cos\theta)\,;$$

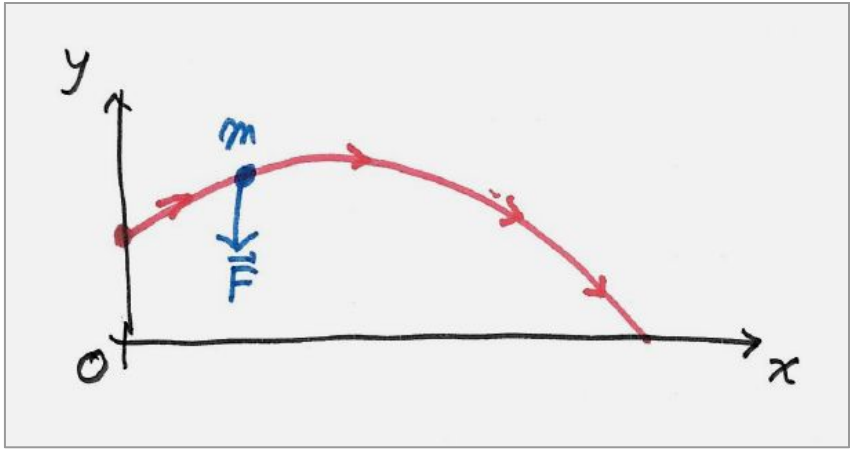
i.e., constant acceleration along x.

- μ = coefficient of friction (PHY 183)

Another example

A projectile in Earth's gravity

(PHY 183)



Determine the motion.

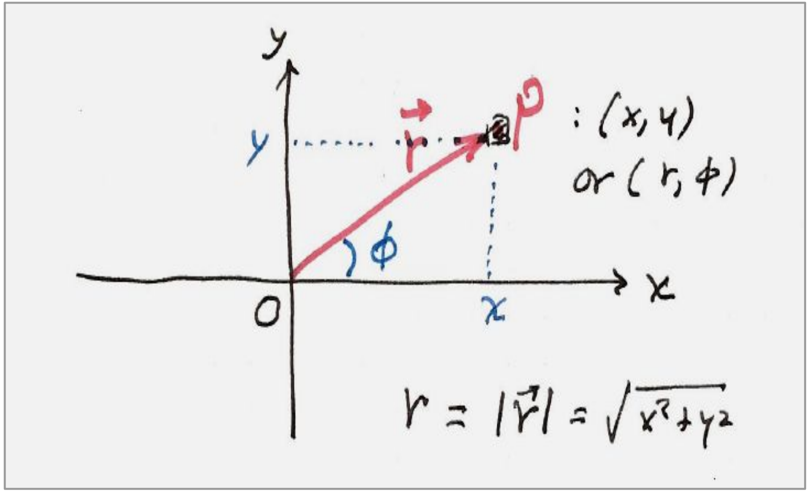
Neglecting air resistance …

- 2D Cartesian coordinates
  x = horizontal coordinate
  y = vertical coordinate
- $F_x = 0$ and $F_y = -m\,g$
- The trajectory is a parabola;

$$x(t) = x_0 + v_{0x}\,t$$

$$y(t) = y_0 + v_{0y}\,t - \tfrac{1}{2}\,g\,t^2$$

SECTION 1.7
PLANE POLAR COORDINATES



Know (and memorize!) the equations that relate plane polar coordinates (r and θ) and Cartesian coordinates (x and y).

$$x = r \cos \varphi$$

$$y = r \sin \varphi$$

$$r = \mathrm{sqrt}(x^2+y^2)$$

$$\tan \varphi = y / x$$

etc.

Example 1.2

The oscillating skateboard

Figure 1.14

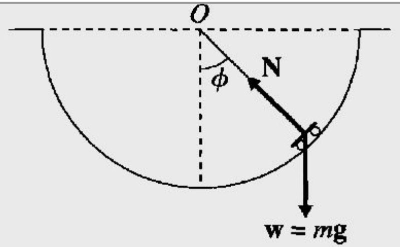


Figure 1.14 A skateboard in a semicircular trough of radius R. The board's position is specified by the angle ϕ measured up from the bottom. The two forces on the skateboard are its weight **w** = m**g** and the normal force **N**.

(It is just the same as a simple pendulum – a mass on a string.)

- It is natural to use plane polar coordinates, r(t) and φ(t) .
- (Do you see why?)
- The *general equations* for polar components of acceleration are, in general,

$$a_r = \ddot{r} - r\dot{\phi}^2 \quad ; \quad a_\phi = r\ddot{\phi} + 2\dot{r}\dot{\phi}$$

- For *circular motion*, r(t) = R ; then

$$-R\dot{\phi}^2 = (mg\cos\phi - N)/m \quad \text{and} \quad R\ddot{\phi} = (-mg\sin\phi)/m$$

$$\ddot{\phi} = -\frac{g}{R}\sin\phi$$

(1.51)

IN-CLASS EXERCISES