PHY 101 – Concepts in Physics

/1/ Homework is assigned on the LON-CAPA web site:

msu.loncapa.org

Log on using your MSU NET ID.

Click on the course PHY 101.

If you need help, go to Room 1248 and ask a teaching assistant (TA) to show you how to use LON-CAPA.

Form study groups with other students in class and work together.

/2/ Next week's class (Thursday, September 5)

When: 8:00 to 10:00 AM

Where: Room 106 Farrell Hall (microcomputer classroom)

/3/ Lecture notes are posted at
www.pa.msu.edu/courses/phy101 .

PHY 101 – Lecture 1
Math. Techniques

1 - Algebra
2 - Trigonometry
3 – Analytic geometry
4 - Computer simulation
5 – Calculus

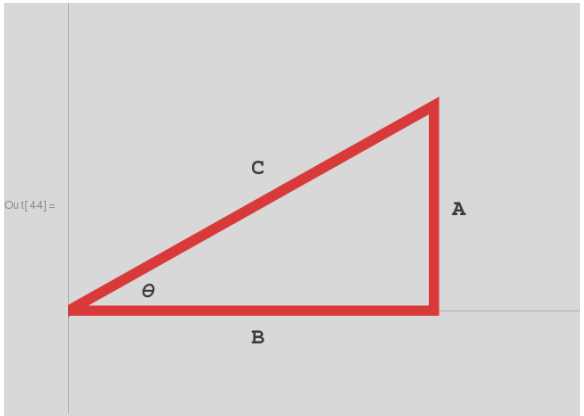
Algebra: Use symbols to stand for numbers.

Example

Two cars travel on a long straight road, shown in the figure. A Ford starts at point B and travels 45 mph. A Chevrolet starts at A, 15 minutes later, and travels 50 mph. Where is the point C where the Chevy will pass the Ford?

2 – Trigonometry

We start with right triangles.

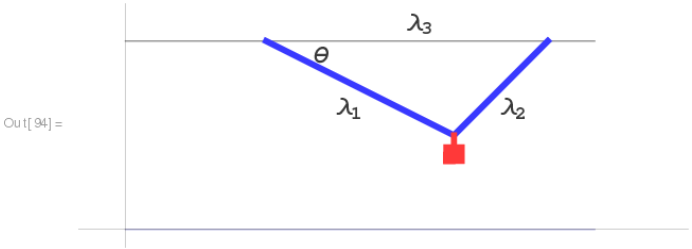


$\sin\theta = A/C$
$\cos\theta = B/C$
$\tan\theta = A/B$

"SOH-CAH-TOA"

But there's more to it than that.

Trigonometry Example



A mass is suspended from a string attached to the ceiling as shown. The lengths in the figure are: $\lambda_3 = 1\,m$ = the distance between the two ends of the string; $\lambda_1 = 0.7\,m$ and $\lambda_2 = 0.4\,m$ = the lengths of the two segments of the string between the ends and the suspension point.
Calculate the angle θ.

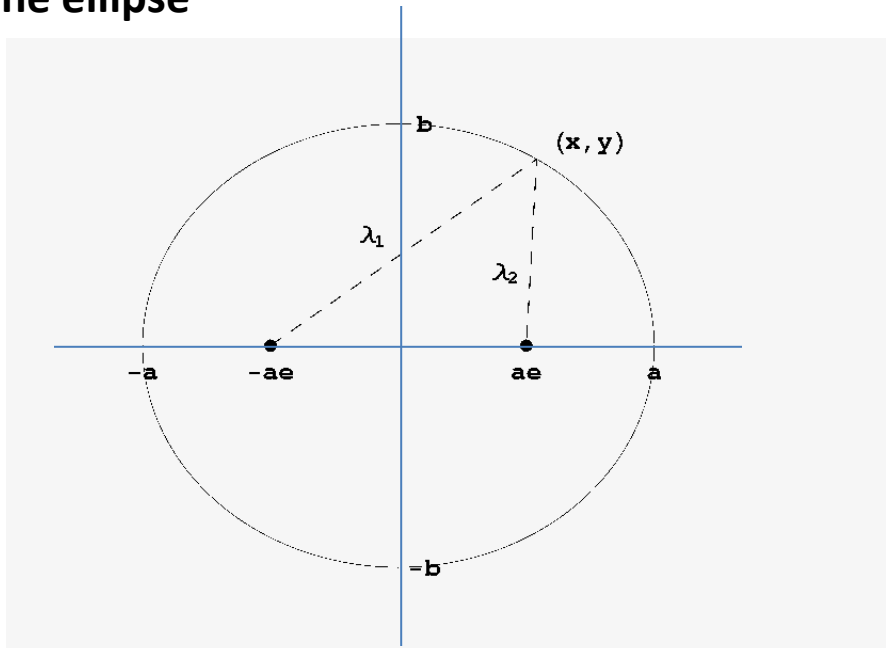
3 – Analytic geometry

Use algebra (and calculus) to analyze geometry problems.

Key technique: coordinates

Rene DesCartes

The ellipse



Ellipse geometry, for an ellispe ceneterd at the origin

Equation: $(x/a)^2 + (y/b)^2 = 1$

a = semimajor axis; b = semiminor axis

The eccentricity is e = $\sqrt{1 - (b^2/a^2)}$

Theorem. $\lambda_1 + \lambda_2 = 2a$

4 - Computer simulation

Learn to use the computer program "Mathematica" which is available in the microcomputer labs in Farrell Hall. (You can't afford to buy it for your own computer, but MSU has a site license.)

For simple computer problems, you could use and EXCEL spreadsheet program, or Wolfram Alpha.
But the easiest way is to use Mathematica.

Calculate the area and circumference of an ellipse.

Preliminary. A circle is a special case of an ellipse; the eccentricity is 0. Semi-major axis = Semi-minor axis

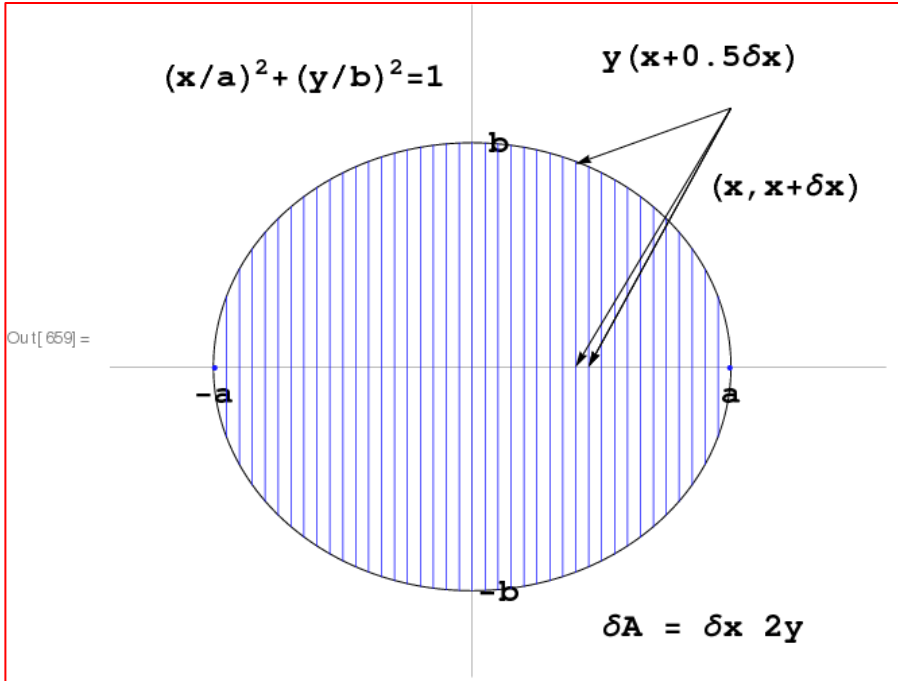
$$a = b = \text{radius } r.$$

Everyone knows the formulas for the area and circumference:

$$\text{Area} = \pi r^2 \; ; \quad \text{Circumference} = 2 \pi r \; .$$

As a numerical example, suppose the radius is 1 m. Then the area is 3.14 m^2 and the circumference is 6.28 m.

Area of an ellipse:



Calculate the area of an ellipse.
Chop up the ellipse into many small strips with width δx.
The area of a single strip is $\delta x\ 2y$.
Add up all the strips.
That's the area of the ellipse.

Computer calculation

N_s = 100 or 1000 or 10,000

$\delta x = a/N_s$

Strip n:

$(x,\ x+\delta x) = (a*n/N_s\ ,\ a*(n+1)/N_s)$

$y(x) = b*\mathrm{Sqrt}[\ 1-(x/a)^2\ ]$

Area of an ellipse

Computer calculation

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Mathematica Example

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(* Numerical calculation using Mathematica *)
{a, ecc} = {1, 1 / 2}
b = a * Sqrt[1 - ecc^2]
y[x_] := b * Sqrt[1 - (x / a)^2]
dx = a / 10000
Area = Sum[dx * 2 * y[dx * (n + 1 / 2)], {n, 0, 9999}] * 2;
N[Area, 10]
N[Pi * a * b, 10]
```

Out[717]= {1, 1 / 2}

Out[718]= $\left(\sqrt{3}\right) / 2$

Out[720]= 1 / 10000

Out[722]= 2.720699345

Out[723]= 2.720699046

Microlabs where you can use Mathematica: Farrell Hall Room 105; Farrell Hall Room 106; Anthony Hall Room 1210.