Ether 2/21/2014

Given yp (y coordinate of apex),
and coords (x1,y1) of a point on the trajectory,
where x1>xp, compute a & b

All xy coords are relative to launch point at (0,0)

```
(%i1) f1: y = a*x^2 + b*x$
      f2: m = 2*a*x + b$
```

set up simultaneous equations:

```
(%i3) q1: ev(f1,y=y1,x=x1);
      q2: ev(f1,y=yp,x=xp);
      q3: ev(f2,m=0,x=xp);
```

(%o3) $y1=a\,x1^2+b\,x1$

(%o4) $yp=a\,xp^2+b\,xp$

(%o5) $0=2\,a\,xp+b$

Solve for a & b and create a function:

```
(%i6) solve([q1,q2,q3],[a,b,xp])[2]$

      ab_ypx1y1(yp,x1,y1):=(
      a:(-2*sqrt(yp*(yp-y1))-2*yp+y1)/x1^2,
      b:(2*(sqrt(yp*(yp-y1))+yp))/x1,
      [a,b]);
```

(%o7) $\mathrm{ab\_ypx1y1}(yp,x1,y1):=\left(a:\frac{(-2)\sqrt{yp\,(yp-y1)}-2\,yp+y1}{x1^2},\ b:\frac{2\,(\sqrt{yp\,(yp-y1)}+yp)}{x1},\ [a,b]\right)$

Example usage:

```
(%i8) goal          : 3 + 1/12$
      bottom        : 6 + 10.75/12$
      top           : bottom + goal$
      ball_radius   : 1$

      launch_height : 3.5$
      yp : (top - launch_height)    - ball_radius$
      y1 : (bottom - launch_height) + ball_radius$
      x1 : 21.9302867486$

      [a,b]: ab_ypx1y1(yp,x1,y1);
```

(%o16) [-0.023776863283001, 0.7218792052362]

... so the equation of the parabolic trajectory in a coordinate system
in which the coordinates of the launch point are (0,0) is:

y = a*x^2 + b*x

... and the equation in a coordinate system
in which the coordinates of the launch point are (0,launch_height) is:

y = a*x^2 + b*x + launch_height