# Example Technology Excercise 7
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## 1 Description of region

The region is bounded by:

```
(%i1) top: 4-0.5*x$
      bottom: 0.2*(x-3)^2+1$
      left: 1$
      right: 4$
```

Suppress the warnings about rational numbers

```
(%i5) ratprint:false$
```

## 2 Find the area

```
(%i6) integrate(top-bottom,x,left,right);
```

(%o6) $\frac{93}{20}$

## 3 Find the volume when the region is rotated about the x-axis

This uses the washer method

```
(%i7) %pi*integrate(top^2-bottom^2,x,left,right);
```

(%o7) $\frac{9393\,\pi}{500}$

## 4 Find the volume when the region is rotated about the y-axis

This uses cylindrical shells

(%i8) `2*%pi*integrate(x*(top-bottom),x,left,right);`

(%o8) $\frac{219\,\pi}{10}$

## 5 Find the volume when the region is rotated about x=-5

This uses cylindrical shells

(%i9) `2*%pi*integrate((x+5)*(top-bottom),x,left,right);`

(%o9) $\frac{342\,\pi}{5}$

## 6 Find the perimeter of the region

First the top function

(%i10) `len_top:integrate(sqrt(1+diff(top,x)^2),x,left,right),float;`

(%o10) 3.354101966249685

Now the bottom

(%i11) `len_bottom:integrate(sqrt(1+diff(bottom,x)^2),x,left,right),float;`

(%o11) 3.222520797970178

The left is easy since it's a vertical line segment

(%i12) `len_left:subst(x=left,top-bottom);`

(%o12) 1.7

Similarly, the right is also a line segment

(%i13) `len_right:subst(x=right,top-bottom);`

(%o13) 0.8

Now find the perimeter by adding all those together

(%i14) len_top+len_bottom+len_left+len_right;

(%o14) 9.076622764219863

## 7 Find the centroid

Find the mass

(%i15) M:integrate(top-bottom,x,left,right);

(%o15) $\frac{93}{20}$

Find My, the moment about the y-axis (x=0)

(%i16) My:integrate(x*(top-bottom),x,left,right);

(%o16) $\frac{219}{20}$

Find Mx, the moment about the x-axis (y=0)

(%i17) Mx:integrate((top+bottom)/2*(top-bottom),x,left,right);

(%o17) $\frac{9393}{1000}$

The centroid is My/M and Mx/M

(%i18) xbar:My/M;
ybar:Mx/M;

(%o18) $\frac{73}{31}$

(%o19) $\frac{101}{50}$

## 8 Find the volume when the region is rotated about 2x+3y=18

The Theorem of Pappus says that the volume
is equal to the area of the region times
the distance traveled by the centroid.

We need the distance between the centroid and the line.

```
(%i20) R:abs(2*xbar+3*ybar-18)/sqrt(2^2+3^2),float;
(%o20) 2.005330677127788
```

Now the volume, using M as the area from the last part

```
(%i21) 2*%pi*R*M,float;
(%o21) 18.64957529728843 π
```

## 9 Find the area of the surface when the top portion is rotated about x-axis

The main formula is 2*pi*r*l, where
r is the radius (y value) and the l is the arclength parameter

```
(%i22) 2*%pi*integrate(top*sqrt(1+diff(top,x)^2),x,left,right);
(%o22) 18.44756081437327 π
```